Fiscal Risks and Impacts Assessment on the Renewable Energy Policies in Indonesia

By

Widodo Ramadyanto

Diploma III of Accounting, STAN, Indonesia

Bachelor of Accounting, STAN, Indonesia

Master of Risk Management, Monash University, Australia

Submitted in fulfilment of the requirements of the degree of

Doctor of Business Administration

College of Business

Victoria University

Melbourne, Australia

2019

Abstract

This thesis tries to assess the Indonesia fiscal risk because of government guarantees for renewable energy development, particularly the development of geothermal power plants. These plants in Indonesia can be developed either by the PLN (a state-owned enterprise) or by private investors. When the plants are developed by private investors, they have to sell the electricity to PLN as it is the only electricity retailer in Indonesia. If PLN build power plants, it needs loans from financial institutions, but due to its financial condition, those financial institutions need government guarantees which ensure PLN's ability to service the debts. Meanwhile, when the power plants are developed by private investors, the investors need to be guaranteed that PLN will be able to pay for the purchased power. These guarantees might create a fiscal risk for the government. The government has been stating fiscal risks in its national budget, but it only focuses on the risk exposures without estimating their probabilities. Therefore, this study tries to complete the current budget statement which provides both exposures and probabilities of fiscal risks from government guarantees for renewable energy projects. Furthermore, the government has been applying a simulation model to assess the fiscal risks but it is in a definite number which does not incorporate uncertainties. Whereas uncertainties can alter the government policy. Moreover, the government model to assess fiscal risk on the power sector incorporates general power plants which may not suitable for the renewable energy power, particularly geothermal power. It is then forecasted that it is likely there will be no government guarantee for geothermal projects for 2018 and 2019. However, with less than 10% probabilities of an exposure of up to IDR 18.8 trillion and IDR 25.2 trillion for 2018 and 2019 respectively. Under 90% certainty, the maximum guarantee exposure will be up to IDR 1.9 trillion and IDR 4.1 trillion. As results, these exposures are categorised as low risk because they are below the threshold value of 0.5% of GDP but the government will have a sufficient cash to pay the maximum possible guarantee amounts. These forecasted figured are based on a Monte Carlo simulation model, a stochastic simulation model, for renewable energy power plants. In practical, this model can act as a tool for analysing guarantee proposals, to estimate fiscal risk and economic impacts of the guarantees, to design fiscal risk control policies. Therefore, this study can be applied for decision making regarding government guarantee in Indonesia. In academic point of

view, this study explains the transmission of fiscal risk from government guarantees on geothermal projects in Indonesia to the fiscal risk. It also enrich academic perspective on fiscal risk management which is differ from other literatures as it explains fiscal risk from the Indonesian government guarantees, adds knowledge on the relationship between government expenditure, government guarantees on renewable energy development and fiscal sustainability in Indonesia, and provides knowledge through a practical and applicable fiscal risk assessment approach on government guarantees. It is concluded that there will be no government guarantee exposure for geothermal projects in 2018 and 2019, so the government need not to allocate the guarantee expenditures in the national budget for the years.

Student Declaration

I, Widodo Ramadyanto, declare that the DBA thesis entitled 'Fiscal Risks and Impacts Assessment on the Renewable Energy Policies in Indonesia' is no more than 65,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

This thesis has been professionally copy edited by Dr Rachel Le Rossignol according to the Australian Standards for Editing Practice. Specifically the standards applied included D1, D3 to D5 and E1, E2 and E4. These standards relate to appropriate academic editing, including clarity of expression, spelling, punctuation and grammar, and ensuring the document meets the examining university's format, style and sequencing requirements.

[redacted]

Widodo Ramadyanto **22nd February, 2018**

Acknowledgements

All praise is due to God (Allah the Almighty) alone, the Sustainer of all worlds, the most gracious, the dispenser grace. Thank you to God for providing me strength, mentally and physically to crawl, walk, and run throughout this doctoral journey. Gratitude also to my whole family, my wife Sri Rahayu Tresnawati, my children Fatih Mirza Syabani and Hilmy Farras Maulidyan, for supporting, and even carrying me when I could not walk with my own feet. Thanks to my mother Suwartini, and father-in-law Tresno Yuwono, whose blessings enlightened my dark roads.

I would like to thank my supervisors Prof Nada Kulendran and Dr Ranjith Ihalanayake, who have been providing a significant amount of support during very a tight time during the last months of my study. It is an honour to work with you. Thank you also to my former supervisor Dr Segu Zuhair who retired from Victoria University in the last semester of my study.

I would like to thank my employer, Ministry of Finance Indonesia who supports me pursuing a higher degree. I also appreciate Australian Award Scholarships for sponsoring my study, including Margaret Jones and Keith Ong as the liaison officers.

Great support came from my friends and colleagues from Victoria University Indonesian Student Association (VUISA), Pengajian Footscray and Baitul Makmur Community who enhanced my experience in Melbourne. Thank you also for Forkopnas which offers sharing of campus live.

Table of Contents

List of Figures

List of Tables

Abbreviations

Capex	Capital expenditures
CICR	Consolidated Interest Coverage Ratio
COD	Commercial Operation Date
DGBFRM	Directorate General of Budget Financing and Risk Management
DSCR	Debt Service Coverage Ratio
EPC	Engineering, Procurement, and Construction
FPO	Fiscal Policy Office
GDP	Gross Domestic Product
GFF	Geothermal Fund Facility
GHG	Green House Gas
IDR	Indonesian Rupiah
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	Independent Power Producer
IQ	Intelligence Quotient
ISO	International Organisation for Standardisation
JBIC	Japan Bank for Inter-Cooperation
LIBOR	London Interbank Borrowing Offer Rate
MEMR	Ministry of Energy and Mineral Resources
MoF	Ministry of Finance
MUV	Manufacturing Unit Value`
MW	Megawatt
MWe	Megawatt electricity
Opex	Operating expenditures

PLN	Perusahaan Listrik Negara
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PSC	Public Sector Comparator
PT	Perusahaan Terbuka (Public company)
PwC	PricewaterhouseCoopers
SAGS	Steamfield Above Ground System
SOE	State-Owned Enterprise
U.S.	United States
USD	United States Dollar
VFM	Value For Money

Chapter 1
Introduction

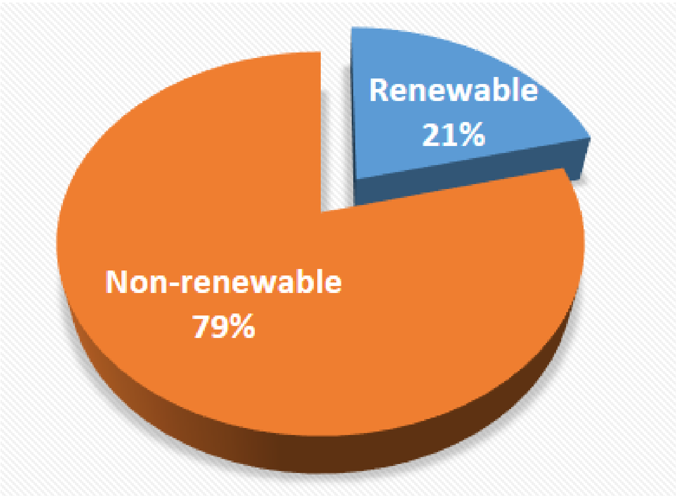
1.1 Introduction

This chapter provides a background to this research, including basic infrastructure conditions in Indonesia, and renewable energy and particularly geothermal development Indonesia. It also presents the research problems, research hypothesis, and a conceptual framework to illustrate the logical flow of this research. This chapter also outlines research contributions as well as the significance and organisation of this thesis.

1.2 Background

Infrastructure is a key factor for a country to achieve economic success (Henckel & McKibbin 2017). As a developing country which needs to achieve a better economic condition, Indonesia needs to improve its infrastructure delivery, particularly in the power sector as currently not all households in Indonesia have access to electricity. On the other hand, Indonesia has many energy resources which are able to generate electricity: fossil fuels such as coal, oil and natural gas, and renewable energy resources such as hydro, biomass, solar, wind, and geothermal (Center for Data and Information Technology 2016). Currently, Indonesia relies more on the non-renewable energy resources and only uses renewable energy resources for around 20% of electricity generation (see ***Figure*** 1**.**1).

Figure 1.1 Energy sources for generating Indonesian electricity, 2014



Source: Center for Data and Information Technology (2015).

Power plant and other infrastructure development have many benefits for Indonesia. Infrastructure improvement is able to increase Indonesian economic growth, raise both government and household revenue and reduce poverty (Irawan et al. 2012). Moreover, improvement of energy infrastructures is vital to economic growth, financial development (Al-Mulali & Sab 2012) and industrialisation (Shahbaz & Lean 2012). The Indonesian government is cooperating with the private sector to deliver more power to the people, especially from renewable energy resources. As the private sector demands a lower investment risk, the government offers government guarantees. These guarantees might put the government at fiscal risk.

1.2.1 Infrastructures

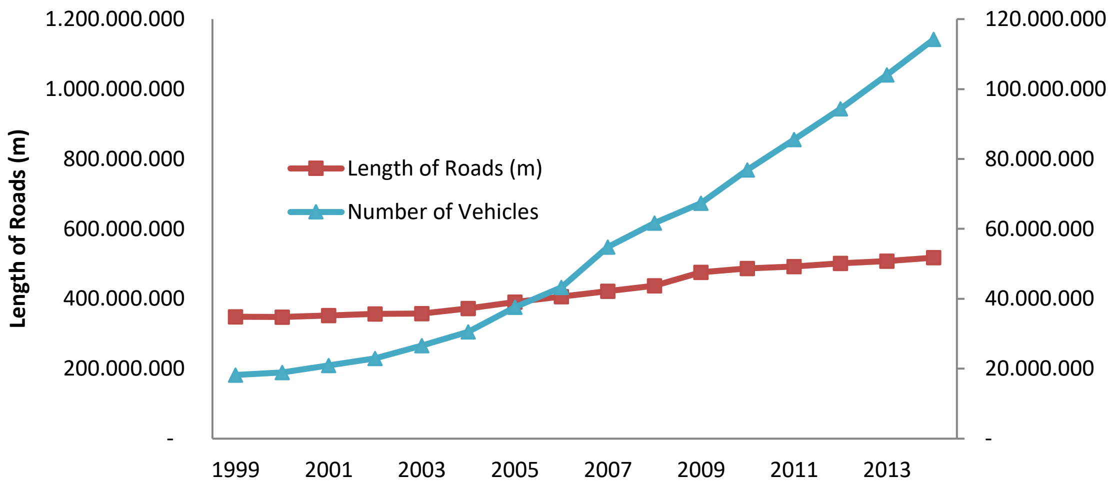
Infrastructure development may be worth the risk, so aside from developing the power sector, to get more positive impacts, Indonesia has been developing its basic infrastructures including roads, water, and electricity (Pisu 2010). Road access is essential to trigger the development of other infrastructure, especially energy infrastructure.

Roads are a fundamental infrastructure required to ensure the development of other infrastructures that need ways to transport machinery, equipment and capital goods. For example, in developing a power plants, it needs generators, turbines, pipes and other materials to be transported from seaports to the project sites through roads.

Furthermore, road networks are necessary for renewable energy power plant development, particularly for geothermal and hydropower plants located in mountain areas, and in some regions, geothermal developers have to build access road and bridges.

Meanwhile, although Indonesia expanded its roads by nearly 50% between 1999-2014 road capacity has remained far behind the growth of vehicles, which has increased by more than five times (see Figure 1.2). Consequently, traffic becomes increasingly congested, particularly in urban areas.

Figure 1.2: Length of roads and the number of vehicles in Indonesia 1987-2014



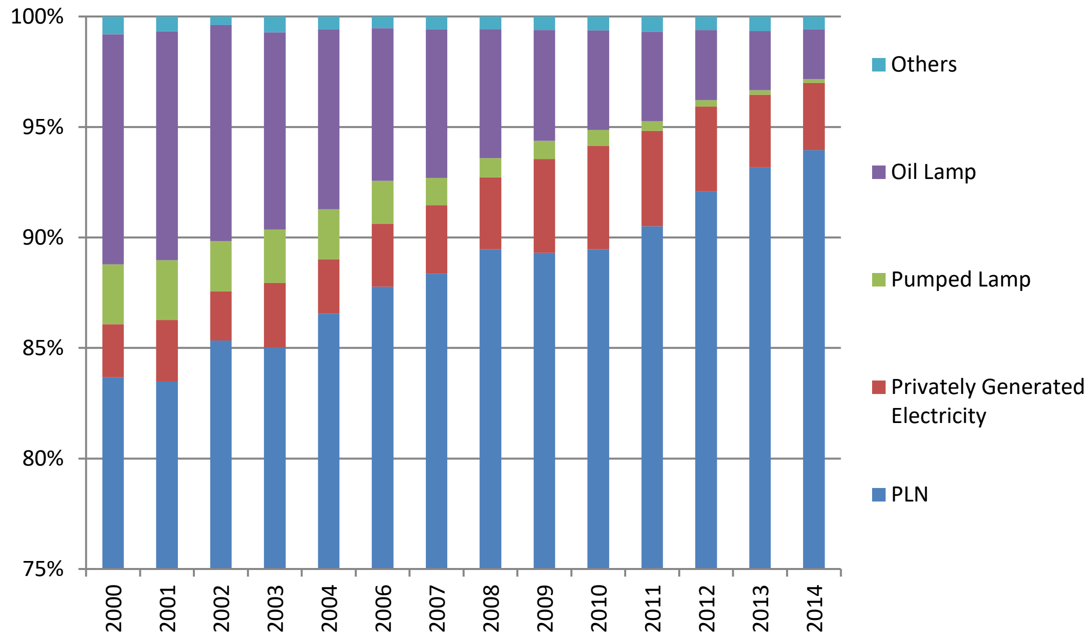
Source: Statistics Indonesia (2016a).

As the government budget for road development is limited, the government has invited private investors to build roads. However, as investments should be profitable and bankable, and the only road type that gives payment is toll roads, investors only build toll roads. For this reason, the government offers incentives to make toll roads more attractive including land capping, which guarantees that the land acquisition cost will not be more than 110% of projected value (Centre for Strategic Studies 2009).

In Indonesia, electricity is retailed by PLN and several small electricity distributors, so practically PLN owns most of the electricity distribution infrastructure. PLN or PT Perusahaan Listrik Negara (Persero) is a state-owned enterprise. PLN sells electricity generated by power plants: PLN's power plants and Independent Power Producers' (IPPs) power plants. IPPs are private investors, either domestic or international, or a combination of both.

The fundamental utilisation of electricity is for lighting. Although there are several sources of lighting, Indonesian people use PLN electricity as the source of lighting. In remote areas not penetrated by the electricity network yet, people use oil lamps, but the number of people using the lamp is decreasing (see Figure 1.35).

Figure 1.3 Source of lighting in Indonesia, 2000-2014



Source: Statistics Indonesia (2014b, 2015b).

Indonesian electricity demand has been growing faster than its supply. Over the last five years, power plant development in Indonesia has been growing at 6.5% per year, whereas, electricity demand has been growing at around 8.5% per year (PT. PLN (Persero) 2015). So, the power supply needs to be developed faster. To catch up with the demand, Indonesia plans to develop 35,000 MW of additional power plant capacity for the period 2016-2020 at the cost of Rp 1,100 trillion to fulfil the electricity needs. The development of power plant capacity is conducted by PLN and IPPs. Due to the current financial condition, PLN is only able to develop 10,000 MW, and the remaining 25,000 MW should be built by IPPs (PT Perusahaan Listrik Negara (Persero) 2016a).

Electricity development in Indonesia is challenged by Indonesia's geographical condition. As an archipelago country, Indonesia has to distribute electricity to more than 15,000 islands, which are not connected to a single electricity grid. It would be easier if all of the islands were connected to a single grid as power plants could be located anywhere in Indonesia at the most feasible place. There are only two sizeable interconnected electricity grids in Indonesia: first, the Sumatra interconnection which connects all electricity distribution on Sumatera Island, the second largest island in the archipelago, and second, the Java-Madura-Bali interconnection, which connects all electricity grids in those three islands, the most populated islands in Indonesia (PT. PLN (Persero) 2015). However, there are many islands located in the off-grid area. Therefore, power plants need to be built across the islands.

Different islands may also have various and specific characteristics which impact on power plant choice. For example, Kalimantan Island has a high electricity demand, a vast coal reserve, and a few geothermal potentials, so the suitable power plant may be coal power. However, Kalimantan is a large island and has many isolated areas. Therefore, other smaller power plants are necessary to supply small villages in small remote regions. Meanwhile, Nusa Tenggara Islands have geothermal potentials but have no coal reserve, so geothermal, and hydropower plants are more suitable for this island.

Table 1.1 Potential of energy in Indonesia

No	**Islands**	**Potential of energy**		
		Geothermal (MWe)	**Coal (million tons)**	**Oil (MMSTB)**
1	***Sumatera***	12,837	68,783	4,528
2	***Java, Madura, and Bali***	10,033	20	1,788
3	***Nusa Tenggara***	537	0	0
4	***Kalimantan***	145	88,002	528
5	***Sulawesi***	3,153	233	47
6	***Maluku***	1,071	8	13
7	***Papua***	75	136	96

Source: Author’s calculation based on Directorate General of Mineral and Coal (2016); (Directorate General of New Renewable Energy and Energy Conservation 2016; Directorate General of Oil and Gas 2016; Direktorat Jenderal Ketenagalistrikan 2016).

Most of the power plants in Indonesia are powered by fossil fuel, mostly coal, and diesel. Coal and diesel have transportation risks as they are transported by trucks and boats. In some areas, boat traffic may be disrupted due to bad weather and high waves, so the supply becomes unreliable. The electricity generation becomes more uncertain with more blackout risk.

Boats are subject to disruptions during severe weather, which in turn contributes to uncertainty in energy production and resulting outages. On the other hand, unlike fossil fuel power plants, renewable energy power plants do not need primary energy supply from other areas. Geothermal power plants generate electricity from steam wells distributed by pipes. So, the transportation risk is predictable and manageable as it relies on the condition of the pipes. Hydropower plants, meanwhile, generate electricity from hydro turbines which are located nearby. Therefore, power supply from geothermal and hydropower are more reliable than fossil-fuel power plants.

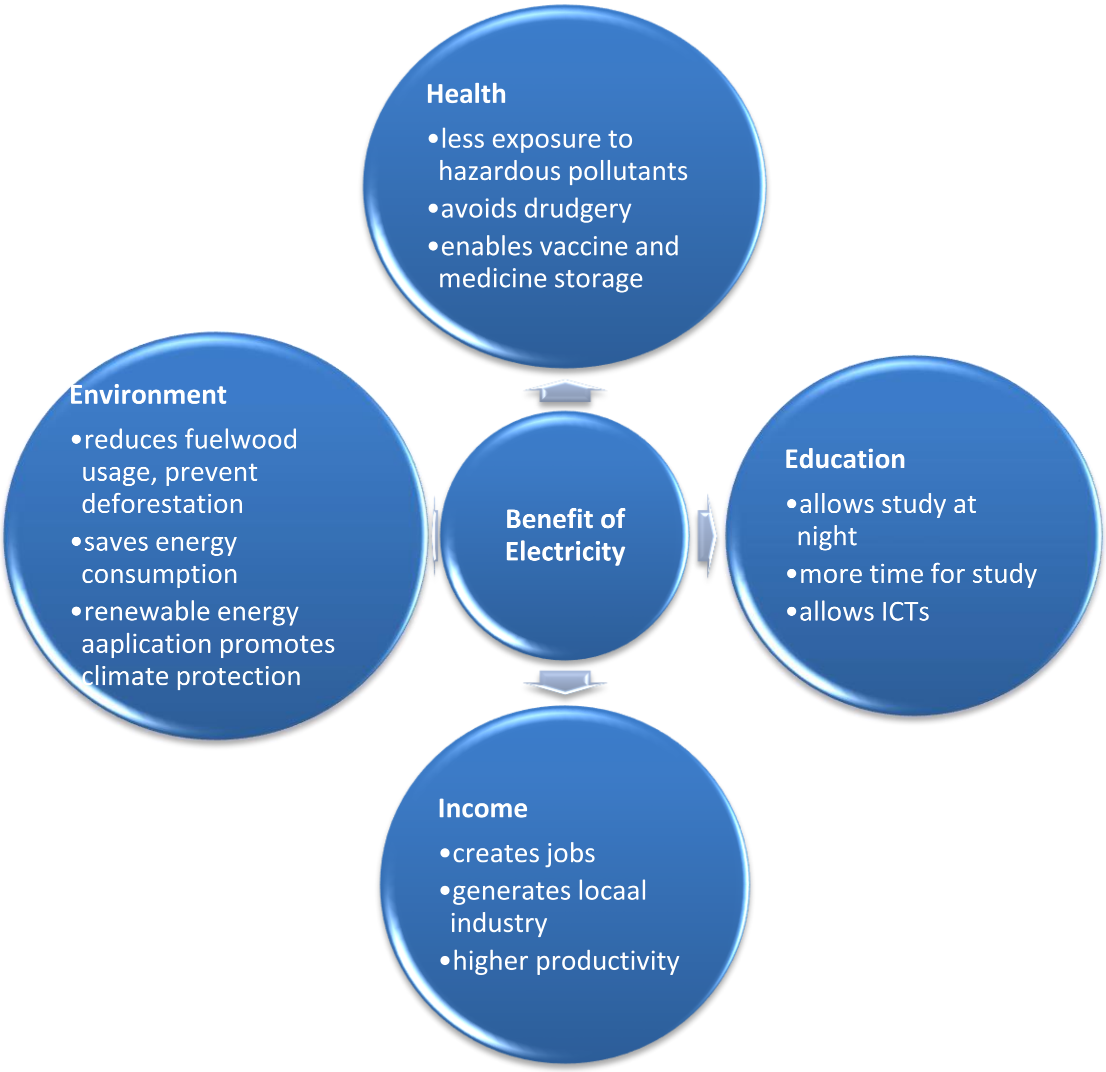
Furthermore, the price of fossil fuels such as coal and diesel fluctuate depending on the international price. These price shifts will be transmitted to the electricity price. Consequently, the electricity cost will also shift. Geothermal steam, on the other hand, is stable for the long term: as long as the concession period. Thus, the electricity cost is more certain.

In addition, Indonesia is currently a net oil importer, including diesel. Therefore, the supply of diesel depends on its supply from other countries. Meanwhile, renewable energy power plants do not depend on other nations' energy supply. So, developing renewable energy power plants can ensure energy security.

Around 15% of Indonesian people have not had access to electricity. It is expected that all individuals in Indonesia will have access to electricity by 2024 (Kementerian Energi dan Sumber Daya Mineral 2015). Electricity has a high positive correlation with economic growth (Apergis & Payne 2011; Chen, S-T, Kuo & Chen 2007; Ferguson, Wilkinson & Hill 2000; Ghosh 2002; Morimoto & Hope 2004). Furthermore, Apergis and Payne (2011) found that the correlation between electricity supply and economic growth has a positive causal impact on economic growth at all income levels, both in the short and long-run. In the case of Indonesia, Irawan et al. (2012) determined that improvements of any infrastructure, including power plants, will boost economic growth and government revenue, and alleviate poverty. Therefore, to ensure a high level of economic growth, sufficient electricity is needed (Chen, S-T, Kuo & Chen 2007).

Kanagawa and Nakata (2008) found that adequate electricity supply has not only a positive economic impact but also a social impact. They found that the availability of electricity can improve health, education and income levels, as well as environmental conditions. For example, it can enable people to study at night so the literacy rate increases (see Figure 1.4). Therefore, to improve Indonesian people's economic and social status, Indonesia needs to have a sufficient supply of electricity.

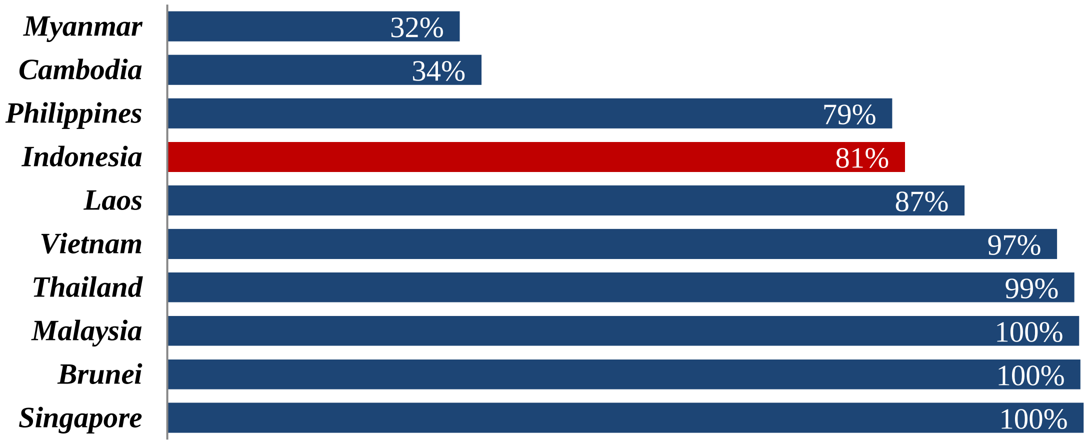
Figure 1.4 Benefits of energy development. Electricity access improves the socio-economic condition of people in developing countries by increasing health, education, income, and environmental quality.



Source: Kanagawa and Nakata (2008, p. 2017).

The government of Indonesia expects to achieve an economic growth rate of 6.1 to 7.1% over the next five years: electricity access should be expanded to support this growth since, among the south-east Asian region, Indonesian people have a low electricity rate (see Figure 1.5). The Indonesian rate is only higher than the Philippines, Cambodia, and Myanmar. In, 2013, the electricity rate was just slightly better than the other archipelago country, the Philippines. However, in terms of the number of people, the Philippines population who had not had access to electricity was smaller, 21 million, compared to 49 million people in Indonesia (International Energy Agency 2016).

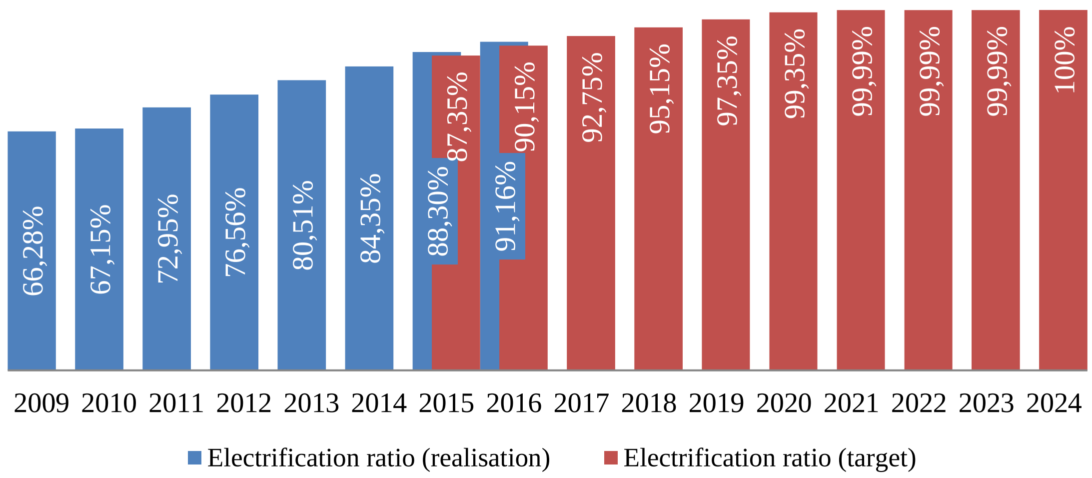
Figure 1.5 Indonesia 2013 electricity rate amongst the lowest in the region. The percentage shows the proportion of people in Indonesia who have access to electricity.



Source: International Energy Agency (2016).

Indonesia set a target to provide electricity to its entire nation by 2024 (see Figure 1.6). The plan is written in the Indonesia National Power Development Plan 2015-2034 (Kementerian Energi dan Sumber Daya Mineral 2015). The first and second years of the program went well as the realisation ratios exceeded the target. It is expected that in the following year if the target is to be met at least 80,500 MW additional electricity will need to be supplied (PT Perusahaan Listrik Negara (Persero) 2016a).

Figure 1.6 Indonesia electrification ratio. The ratio reflects the percentage of households in Indonesia who have access to electricity.

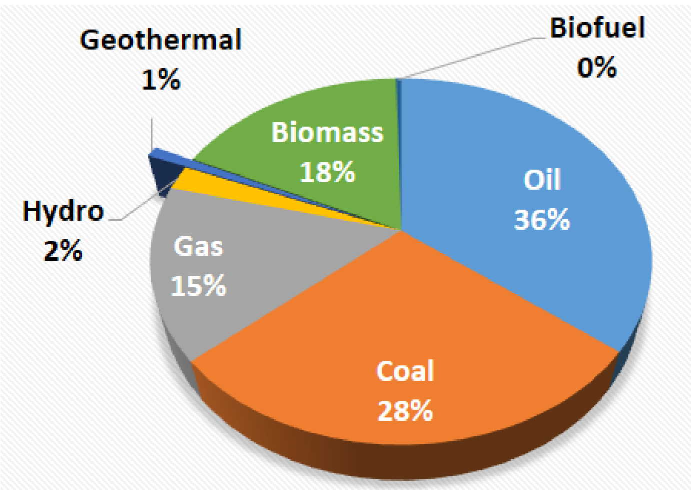


Source: Direktorat Jenderal Ketenagalistrikan (2015); Kementerian Energi dan Sumber Daya Mineral (2015); PT Perusahaan Listrik Negara (Persero) (2016b); Sujatmiko (2017).

1.2.2 Renewable Energy

The additional electricity supply needs to be sourced from additional power plants. By 2014, most electricity in Indonesia was generated from fossil fuel, mainly from oil, coal, and natural gas. The only renewable energy contributing more than 10% was biomass, the other renewables such as hydropower and geothermal only contributed 2% or less.

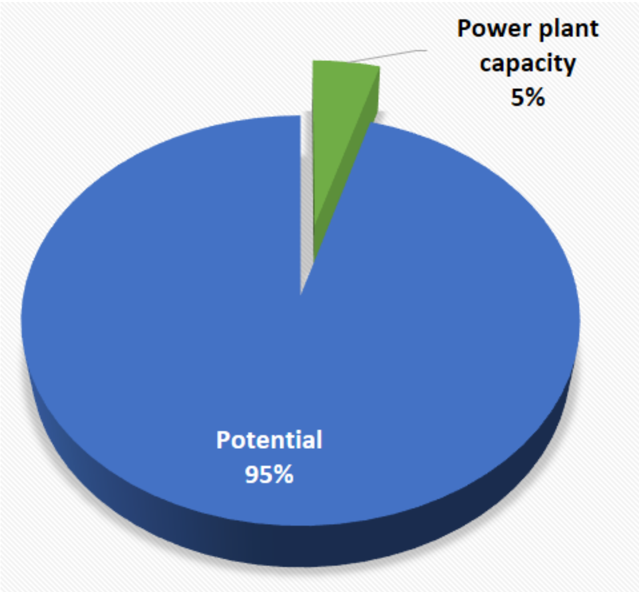
Figure 1.7 Energy mix for electricity generation in Indonesia for 2014



Source: Center for Data and Information Technology (2015).

Indonesia has a high potential for renewable energy, but it is not well developed. For example, Indonesia has 28,910 MW geothermal potential (but less than 5% has been developed) (see Figure 1.8), 61,672 MW wind power potential (currently undeveloped), and 150,000 MW wave power potential (currently undeveloped) (Direktorat Jenderal Energi Baru Terbarukan dan Koservasi Energi 2015). Regarding hydropower, Indonesia has more than 75,000 MW energy potential, but only around 6% has been developed (Center for Data and Information Technology 2015). Moreover, along with the increasing investment in energy projects, Indonesia has committed to reducing Green House Gas (GHG) emissions (Hartono, Irawan & Komarulzaman 2014). Therefore, developing more renewable power plants to fulfil its electricity needs is a reasonable option.

Figure 1.8: Geothermal potential vs development, 2014

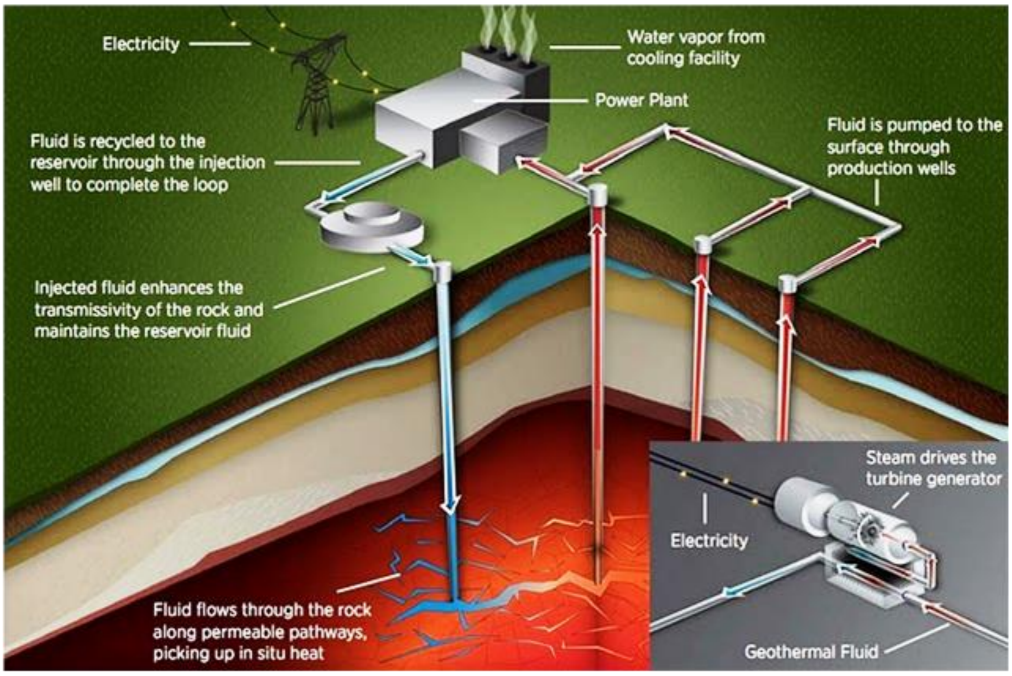


Source: Center for Data and Information Technology (2015).

This study focuses on geothermal development as geothermal policy is controlled by the central government. Hydropower policy is governed by both central and municipal government. Meanwhile, there is no working solar and wind power plant yet which can prove the effectiveness of those power plants working in Indonesia.

Geothermal energy, in general, is heat energy from inside the earth, with sources such as water, rock or steam several kilometres deep (Kanoğlu & Çengel 1999; Kuo 2012; Ryan, V 2005). People can use this heat directly, as steam, hot water or to heat buildings, or indirectly, to generate electricity. This heat comes from magma, both volcanic and nonvolcanic, deep inside the earth (U.S. Energy Information Administration 2016). Wells need to be drilled to extract this heat. The depth of this well varies depending on the location and its heat source: in Indonesia, it needs 1,400 – 2,600 m depth (IEA 2011; Japan International Cooperation Agency, West Japan Engineering Consultants Inc & Ministry of Finance Indonesia 2009). According to Dickson, M.H. and Fanelli (2013); IEA (2011), most power plants use steam to rotate turbines, which results in electricity generation. Unlike fossil-fuel power plants which burn coal, oil or gas to boil water in order to make steam, geothermal power plants use natural steam produced by geothermal reservoirs (see Figure 1.9).

Figure 1.9 Geothermal system



Source: Geothermal Technologies Office (2012)[1].

In Indonesia, geothermal energy is mainly for indirect utilisation, for electricity generation. Before being able to utilise it, developers need to win geothermal bidding (Republic of Indonesia 2014). Once the winning bidder wins the project, it needs to do exploration drilling to find the geothermal reservoir. The drilling can find steam, which can generate electricity, or find nothing, therefore, the bidder will be exposed to drilling and reservoir risk because of their uncertain condition (Sacher & Schiemann 2010). Cui

[1] The image is in the public domain

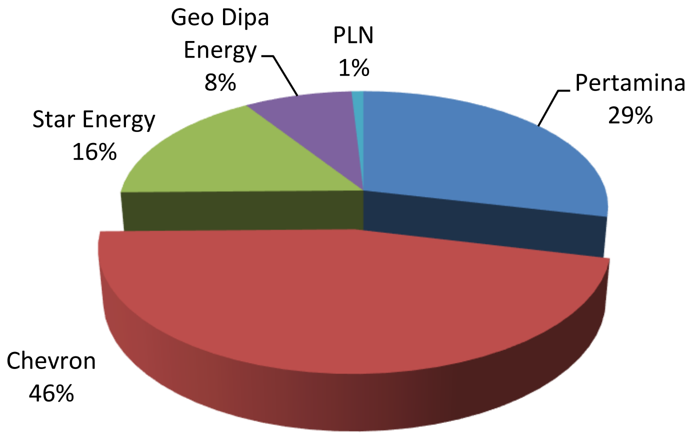
(2010) suggests implementing a Monte Carlo simulation to assess these drilling and reservoir risks. It was found by Sanyal and Yasukawa (2013) that some geothermal fields in Indonesia have a drilling success rate below 50%. Moreover, the drilling cost and reservoir maintenance comprise 40% of geothermal energy costs (Stefánsson 2002). These risks might make many private companies reluctant to invest in geothermal power plants, so that more than 90% of geothermal potential in Indonesia is undeveloped. Therefore, the government has established direct and indirect fiscal incentives to make the power business, including geothermal power, more attractive. The direct incentives consist of public expenditure to directly finance the projects, such as through project preparation costs and government spending to expand electricity transmission and distribution (The Republic of Indonesia 2014). Especially for renewable energy, the government provides additional direct incentives for renewable energy development, for example tax, and tariff facilities (Menteri Keuangan Indonesia 2010a).

1.2.2.1 Potential for foreign investments and their implications

The undeveloped geothermal potential opens an opportunity for domestic and foreign investors to invest in the geothermal sector. Investing in geothermal can be in the form of debt or capital participation. Participating in debt can be conducted by providing project loans to geothermal power plant projects while participating in capital can be conducted by establishing a company which intends to develop power plant project(s). Currently, most foreign investment is in the form of debt and very little is in the form of equity. Typically, the financial structure of infrastructure projects in Indonesia is 70% debt and 30% equity (Cheah & Liu 2006; Esty & Megginson 2000; Sorge 2004). Therefore, there is an opportunity for foreign financiers to be indirectly involved in the renewable projects of Indonesia.

Besides these standard financing approaches, foreign geothermal investors have also had the chance to make foreign direct investments. For example, by 2014, the most significant geothermal generator in Indonesia was Chevron, a US-based multinational energy corporation (see Figure 1.10). Another mean of investment is by co-operating with domestic corporations to form a joint venture to reach 30% equity portion and then find 70% of the funding from foreign financiers. PT Supreme Energy is an example of such joint projects for the development of three geothermal areas in Indonesia (PT Supreme Energy 2015).

Figure 1.10 Geothermal investors in Indonesia, 2014



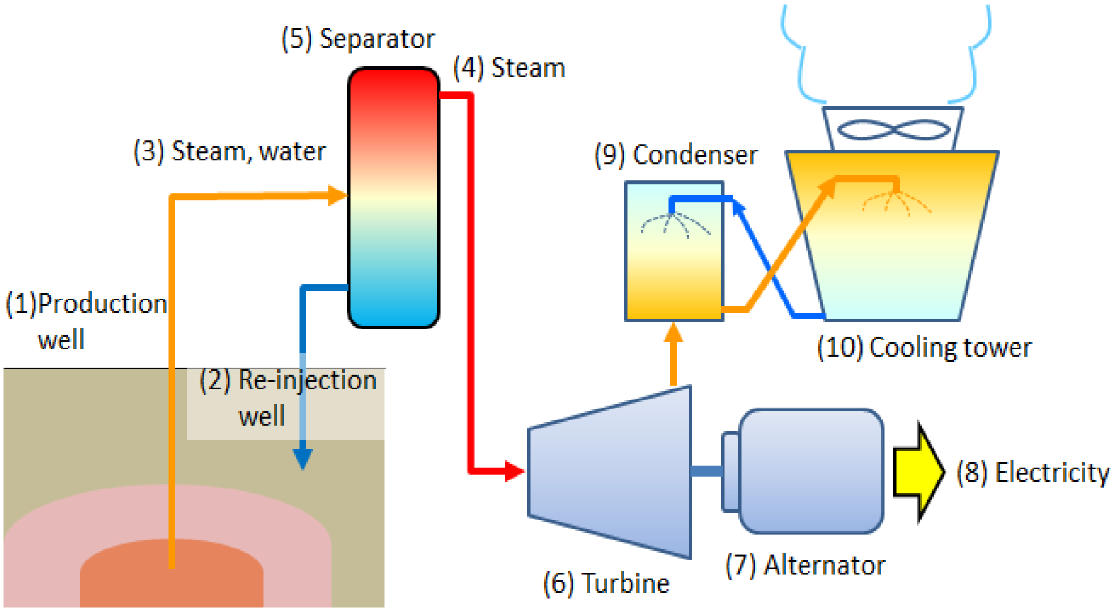
Source: Center for Data and Information Technology (2015).

As foreign investments have positive impacts on geothermal development, Indonesia needs to open more access to investors. In the meantime, to develop a geothermal site, an investor, including foreign investors, must win a geothermal project. A number of foreign investors may result in more bidders in one geothermal project. Therefore, the bidding will be more competitive and can enable the best electricity price.

1.2.2.2 Geothermal Power Plant

Geothermal energy in Indonesia is mostly for indirect use, generating electricity (Center for Data and Information Technology 2016). Figure 1.11 shows how to extract geothermal heat into electricity. Steam and water from production wells (1) are distributed to a separator (5) to separate steam and water. This water is then injected into the earth through a re-injection well. Meanwhile, the steam (4) circulates through a turbine (6) and rotates an alternator (7) to generate electricity (8). Steam from the turbine is dispensed to a condenser (9) and a cooling tower (10) to change this steam into water. This water will be accumulated and re-injected into the earth (Dickson, Mary H. & Fanelli 2004; Office of Energy Efficiency and Renewable Energy 2017; Purnomo & Pichler 2014; Ryan, V 2005).

Figure 1.11 Diagram of geothermal power plants



Source: S-kei (2012), public domain picture.

The initial geothermal drilling exploration in Indonesia was conducted in 1926 at Kamojang, West Java by drilling shallow holes in a large fumarole field. The shallowest well (66 m) was able to discharge 8 MW steam with a temperature of 140 degree Celsius for 50 years (Hochstein & Sudarman 2008). For the last few decades, Chevron Geothermal, which operate in the Kamojang area, has been the largest geothermal power producer (Center for Data and Information Technology 2016).

1.2.2.3 Geothermal Risks

Geothermal projects have several risks, including exploration and construction risks, but the most significant one is an upfront risk regarding exploration, particularly drilling. In geothermal exploration drilling, one result may be a dry hole which does not have any hot steam (Deloitte 2008). Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) found that these exploration risks are related to well depth, steam production and steam/water ratio.

In Indonesia, a geothermal project is tendered based on the electricity price before the exploration stage. Meanwhile, power companies need to capitalise the exploration risk into the electricity price. As a result, during geothermal project tendering, all contestants charge a risk premium: an assessment of their perceived risks. As a result, geothermal electricity might be overpriced (Japan International Cooperation Agency, West Japan Engineering Consultants Inc & Ministry of Finance Indonesia 2009).

To overcome this issue, the government provides an option to explore the geothermal area before a tender is conducted, so the government bears a dry hole risk. This exploration is financed by the Geothermal Fund Facility (GFF) but only for geothermal areas which are not tendered yet (Menteri Keuangan Indonesia 2012a). This study estimates fiscal risk regarding geothermal projects in 2018 and 2019 which had already been tendered in 2013 and 2014 without implementing GFF. Therefore, this study does not consider GFF in the simulation approach.

1.2.3 Geothermal Developers

A geothermal power plant can be developed in two ways: first, a state-owned enterprise named PT Perusahaan Listrik Negara (Persero), known as PLN, or second, an Independent Power Plant (IPP), that is, private investors, either domestic or international or a combination of both.

The Indonesian government has been promoting geothermal power plant development by providing government guarantees for geothermal developers. Under this guarantee policy, the government will pay the geothermal investors if the guaranteed event occurs. Therefore, the government needs to allocate a specific amount of budget every year during the guarantee period for the guarantee payment. However, the guaranteed payment each year is not certain: it might or might not happen. If it happens, it is also not certain how much the payment will be. If the guarantee payment exceeds the budget for guarantee payment, the government will be exposed to a fiscal risk. Meanwhile, an excessive guarantee budget can make the government lose its opportunity to spend its budget for more productive expenditure, including building roads and schools. Therefore, this research aims to estimate the guarantee call, so the fiscal risk is low without excessively allocating the government budget.

1.2.3.1 PLN and Geothermal Development

Although being the monopoly electricity retailer in Indonesia, PLN cannot generate enough profit to fulfil its investment needs. PLN’s financial capacity to build power plants is limited as its retained earnings are not sufficient to finance all the financial needs for power plant development (PT Perusahaan Listrik Negara (Persero) 2016d). Furthermore, PLN is not a public company so it cannot issue shares to get equity financing. PLN also cannot rely on capital injection from the government as the national budget is also limited and there are other national priorities. The last option for PLN to generate investment financing is from debt, but PLN's ability and capacity to take more debt is restricted by loan covenants: a commitment to maintain PLN's financial condition as mandated by the debt agreements. The existing covenants require PLN to retain its Consolidated Interest Coverage Ratio (CICR) and Debt Service Coverage Ratio (DSCR) (PT Perusahaan Listrik Negara (Persero) 2016b).

The global bondholders of PLN require PLN to maintain its CICR at two times. CICR shows the company's cash capacity to pay loan interest by scaling the consolidated cash flow to consolidated interest expense. So, PLN needs to keep its net cash flow at least double its consolidated interest expense. For 2015, the PLN CICR was three times.

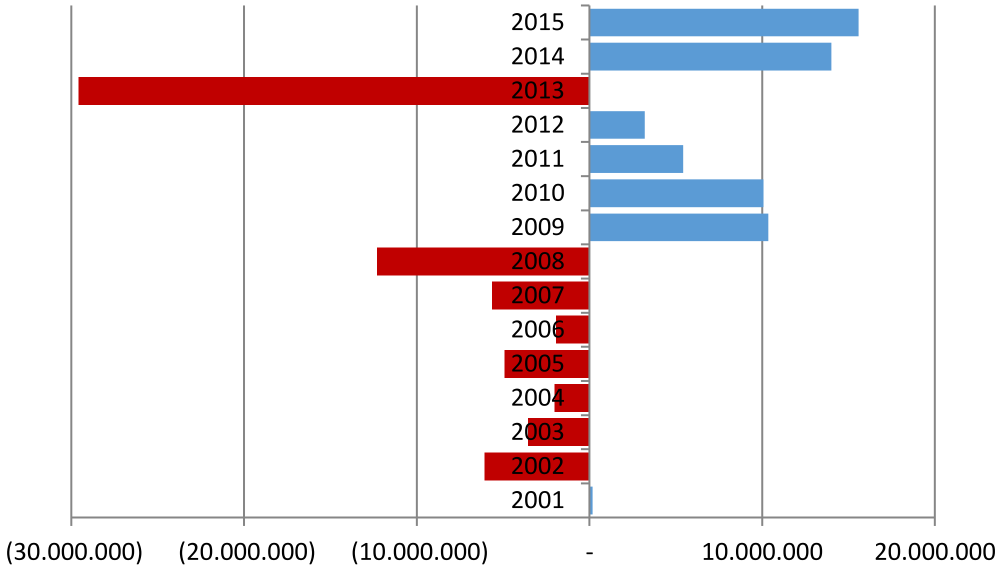
Meanwhile, foreign lenders demand PLN show that it is able to service its loans. They require PLN to manage its DSCR to minimum 1.5 (PT Perusahaan Listrik Negara (Persero) 2016b). As DSCR compares to cash flow and debt service, PLN has to keep its cash flow at least 150% of its debt repayment cost. The DSCR for 2015 was 1.52.

$$DSCR = \frac{Earning\ after\ tax + Depreciation + Interest\ expense + Other\ noncash\ items}{Principal\ repayment + Interest\ expense + lease\ payment} \tag{1.1}$$

Source: Chandra (2014); Rossi (2014).

The 1.52 DSCR only gives PLN a small margin to add debt. However, before giving a loan, the lenders need to be confident that PLN can repay it. PLN profitability has not been stable (see Figure 1.12). For the last 15 years, PLN suffered more losses than gain, so it is a risky business to give PLN a loan. The government, then, step up to tackle the risk by providing the creditor's Debt Guarantees. The government make sure that PLN will be able to service its loan. If PLN does not has the cash to pay the loan, principal and interest, the government will pay it (Menteri Keuangan Indonesia 2016).

Figure 1.12 PLN net incomes in IDR million 2001-2015 fluctuated



Source: PLN annual reports for the period of 2001-2015.

If PLN wants to develop a geothermal project, PLN might finance the project by debts. The banks, creditors, and financiers need to be confident that PLN is able to repay the project loans. To increase PLN bankability, the government provides a Debt Guarantee, which means that the government will pay the PLN project debt if PLN fails to do it (Menteri Keuangan Indonesia 2016).

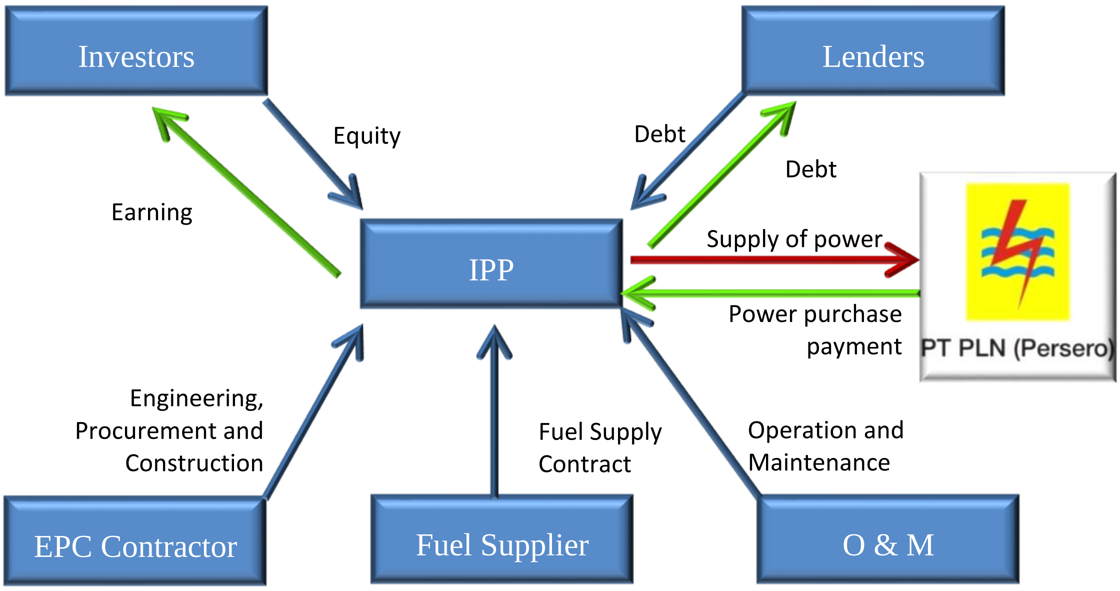
1.2.3.2 IPP and Geothermal Development

Another option to develop power plants is by offering the power plant projects to private investors (IPPs). This option does not require PLN to ask the government for additional capital or to find additional debt. Under this scheme, IPPs receive funding from investors and lenders in the form of equity and debt. IPPs then assign Engineering, Procurement, and Construction (EPC) contractors to build the power plant. After it is commercially operational, the IPP may cooperate with operation and maintenance contractors to do the operation and maintenance.

To secure the primary energy supply, IPPs sign a long-term contract with fuel suppliers. For the case of renewable energy, IPPs usually produce their own source of energy. With geothermal power, for example, geothermal developers produce their own steam that will be used to turn turbines and generate electricity (President of the Republic of Indonesia

2014a). In this scheme, IPPs supply electricity to PLN (see Figure 1.13) on a take or pay basis (Wells 2007). This means that PLN agrees to purchase and pay for a minimum volume of electricity from IPPs over a contracted period (PwC 2016). Considering the monopoly business of PLN, and the financial condition of PLN, IPPs demand a certainty that PLN's financial condition will always be viable to make the payment. Therefore, the government provides a business viability guarantee that ensures PLN financial condition will always be feasible to make the payment.

Figure 1.13 Typical business of an IPP project in Indonesia



Source: IPP Procurement Division PT PLN (Persero) (2013).

Atmo and Duffield (2015) argue that a power project is attractive when it is commercially feasible. As project feasibility depends on its revenue and cost, the Indonesian government tries to reducing investment cost by providing several incentives such as tax and tariff facilities (Menteri Keuangan Indonesia 2010a). Moreover, as a power plant project requires project loans from banks and other lenders, the project has to be bankable. Therefore, the government also provides government guarantees to ensure the business viability of the project (Menteri Keuangan Indonesia 2011b, 2016). If a geothermal project is owned by an IPP, PLN and the IPP are bound by a Power Purchase Agreement (PPA) which makes PLN liable to purchase electricity generated from the project. The IPP needs to be assured that PLN will always be able to pay for the electricity during the duration of the agreement. To convince the IPP, the government provides a guarantee that

PLN will always be able to keep the contract. Under a Business Viability Guarantee, the government will take measures to ensure that PLN's financial condition is able to fulfil the electricity purchase obligation (Menteri Keuangan Indonesia 2011b).

1.2.3.3 Fiscal Risk and Government Guarantee Program

The government guarantee is a legal obligation for governments to make payments if triggering events occur: as a consequence, the fiscal cost is invisible until they come due (Polackova 1999). This indirect incentive is uncertain in term of its probability, which varies from low to highly probable, and whether the loss amount can be precisely estimated or not. Therefore, according to the Indonesian government accounting standard, it should be classified as a contingent liability (Presiden Republik Indonesia 2005). According to Brixi and Schick (2002); Polackova (1999), government contingent liabilities are a government's obligation to make a payment if particular events occur.

Contingent liabilities arising from government guarantees may have adverse impacts on the people. Since the probability and amount of loss are not always measurable, the government may not have sufficient fund to pay the liabilities. As a result, the government needs to re-allocate expenditure which may be required to support the economy. For example, the government can re-allocate its healthcare budget to pay a government guarantee on a geothermal project. An increase in contingent liabilities has the potential to worsen its sovereign risk (Gapen et al. 2008) which in turn can create macroeconomic instability (Corsetti et al. 2013). Canuto, Dos Santos and de Sá Porto (2012, p. 3) defined sovereign risk as "credit risk associated with operations involving credit for a sovereign state". These contingent liabilities can become a fiscal risk. Fiscal risk can be defined as "fiscal obligations which are **contingent** on the occurrence of particular events, but these obligations are not budgeted and accounted for, nor are they considered in conventional fiscal analysis" (Polackova 1999, p. 46). Overall, government incentives to increase investment in energy projects can lead to fiscal risks, so it is essential to determine optimal energy policies that would minimise fiscal risk and maximise economic impacts.

These guarantees have fiscal consequences: as the exposure of guarantee is uncertain (Irwin 2007), it likely creating a fiscal risk (Cebotari et al. 2009; Sfakianakis & Laar 2013; Takashima, Yagi & Takamori 2010; Ter-Minassian 2005). This uncertainty of risk needs to be assessed and quantified to ensure fiscal sustainability (Brixi & Schick 2002).

Therefore, this study tries to quantify the uncertainties of the guarantee by predicting its probability and consequences to ensure an optimal policy level to be formulated so that the benefits of including IPPs and creditors outweigh the risks.

1.3 Research Objective

The aims of this research are:

a. To quantify fiscal risk from government guarantees on renewable energy development;
b. To estimate the probability and consequence of the fiscal risk (level of the fiscal risk); and
c. To determine policy levels that would minimise fiscal risk.

1.4 Research Problem

Government support on the renewable energy problem may or may not has fiscal consequences. This issue should be addressed properly as a wrong fiscal risk assessment can cause a severe problem. If the government fails to recognize government financial obligation from the government guarantee policy on the renewable program, the government may not have sufficient fund to pay this obligation. This inability will lead to other problems such as legal and reputation risks or even government bankruptcy. Therefore, this research will examine whether the government support programs for renewable energy projects create any fiscal risk in the government expenditure.

As risk is a function of probability and consequence, so once a fiscal risk is identified, both of them need to be identified. So, the budget has to be allocated based on the most probable consequence. An under-budgeted fiscal risk financing has a similar effect to the unidentified fiscal risk. On the other hand, an overbudgeted fiscal risk make the national budget become less effective and efficient. It will be less effective because the allocated budget can be used to finance other important spendings such as infrastructure development. Whereas it will be less efficient because the Indonesian budget is a in deficit condition and to finance this deficit, the government acquire debt, so any idle money or undisbursed budget cost at least the government cost of debt. Therefore, this research will assess the probability and consequences associated with the fiscal risk to ensure an effective and efficiency budget.

Related to the budget effectivity and efficiency, the government support program for the renewable energy projects need to be reviewed so that the program has minimum fiscal risk. Currently, the government absorb the risk by expending money to eliminate the risk. However, there are some policy options which may be available for the government. Therefore, will exercise policy option to minimise the fiscal risk.

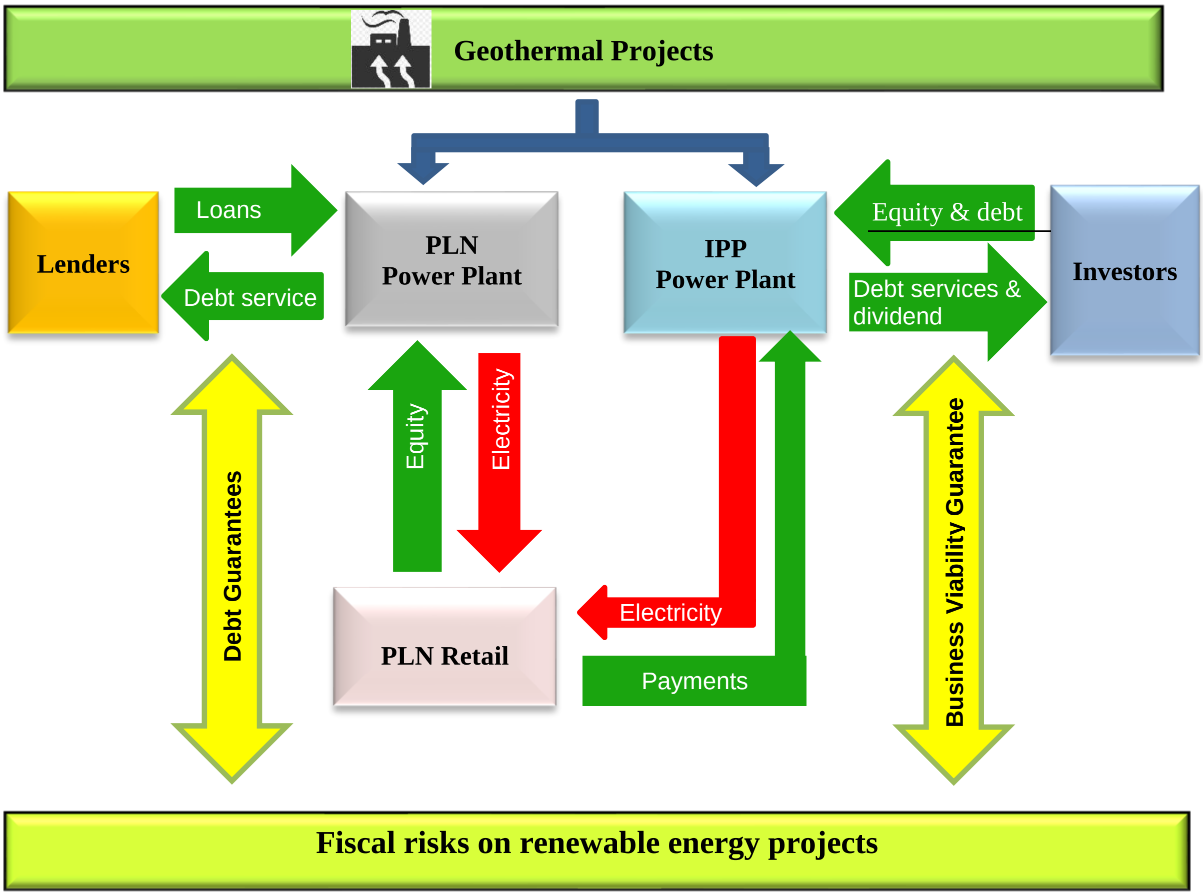
1.5 Research Hypothesis

A Debt Guarantee and Business Viability Guarantee make the Indonesian government allocate a guarantee payment in its national budget. This research will test the hypothesis of whether the government needs to allocate funds from the government expenditure budget for these guarantee programs.

1.6 Conceptual Framework

A geothermal power plant can be developed either by PLN or an IPP. When PLN build a geothermal project, PLN acquires loans from lenders that are dedicated to financing the project. PLN also injects capital into the project. After the Commercial Operation Date (COD), PLN starts to repay the loan for the loan term. If the project cannot fulfil this obligation, PLN (as the sponsor and parent company) has to take it over. However, if PLN cannot do it, the government will tackle this debt servicing under a Debt Guarantee policy. When the geothermal power plant is built by an IPP, PLN purchases the generated electricity from IPP. PLN then retails the purchased electricity to its customers and uses the revenue to pay the IPP. If the revenue is less than PLN's financial obligation to the IPP, PLN will suffer a deficit. If PLN cannot pay the deficit to the IPP, the government will tackle this payment under the Business Viability Guarantee policy. The government payment to the lenders and IPP because of the government guarantee is treated as a fiscal risk (see Figure 1.14).

Figure 1.14 Conceptual framework for this research



This study will implement a Monte Carlo simulation to assess the risk and probabilities of the fiscal risk. The result will be analysed to measure its severity in relation to the national budget. In the end, policy recommendations are formulated to minimise the fiscal risk.

1.7 Research Contribution

A fiscal risk is a function of likelihood and fiscal impact, so to assess fiscal risk both likelihood and fiscal impact needs to be measured. For the case of renewable energy in Indonesia, some researchers have tried to assess its fiscal impacts. Yusuf et al. (2010) have quantified impacts of Indonesian government policies on renewable energy to the national budget. However, this model is only applicable to biofuel and deterministic. A deterministic model assumes 100% certainty level which does not consider any changes in macroeconomic and project variables without considering the project and business risks.

From the business perspective, Sadorsky (2012) modelled renewable energy company risk using some risk determinants including the size of the firm, debt to equity ratio, research and development expenditure to sales ratio, sales growth, and oil price return. He found that government support impacts on a projects' profitability, but he did not excise the effect of government guarantee.

Regarding government guarantees, Sun and Zhang (2015) found the effects of government guarantees for the administration and business of water treatment projects in China. However, the study only considered a minimum revenue guarantee and is applicable only to China. The International Monetary Fund and World Bank Group (2016) created a generic model for assessing fiscal risk for PPP projects. Its model is comprehensive as it assesses construction risks, demand risks, operational and performance risks, financial risks (including guarantees), force majeure, material adverse government actions, changes in the law, rebalancing of financial equilibrium, renegotiation and contract termination. Regarding the impacts of guarantee policy, it only considers partial debt guarantees and minimum revenue guarantees: business viability guarantees are not yet taken into account.

For the Indonesian case, Wibowo et al. (2012) reviewed the impact of government support on a toll road project. However, that research fails to explain the guarantee impacts linked to the fiscal risk. The proposed model in this thesis will consider government support impacts for business, projects and government. It will also focus on renewable energy, particularly geothermal projects.

Regarding geothermal energy in Indonesia, Castle Rock Consulting (2010); Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) have identified geothermal project costs. However, they view these at project level without investigating the government's cost. The Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) found that government incentives can reduce the geothermal cost, but they do not consider the impact of government incentives on government expenditure and fiscal risk.

Overall, this research is expected to add an academic perspective on fiscal risk management. This study differs from other findings related to fiscal risk management in the following areas:

a. First, it explains the fiscal risk in the government expenditure on government guarantees in Indonesia;
b. Second, it adds knowledge on the relationship between government expenditure, government guarantees on renewable energy development and fiscal sustainability in Indonesia;
c. Third, it provides knowledge through a practical and applicable fiscal risk assessment approach on government guarantees.

The timeliness of the proposed research is enhanced by the Indonesian government establishing *Presidential Degree number 4, year 2016, regarding Acceleration on Electricity Infrastructure Development*, which includes guarantee policies for the 35,000 MW program.

1.8 Significance of the research

Incentives to private sectors do come with consequences. When the government is unable to fulfil its obligation under a guarantee, the investors are likely to claim damages, which could result in severe consequences. Some of the possible effects are downgrading of the country's credit rating, depreciation of the currency, and a bearish stock market. These conditions may cause further economic impacts such as inflation and negative trade balances.

The government has been stating fiscal risks in a section titled Fiscal Risk Statement in the national budget (The Republic of Indonesia 2014). However, it focuses on the risk exposures without estimating their probabilities. This proposed study provides a tool to estimate the probabilities for fiscal risks from government guarantees for renewable energy projects.

The government has been applying a simulation model to assess the fiscal risks (Bachmair 2016). However, the current simulation model suffers from two main limitations. Firstly, the model is deterministic and does not incorporate uncertainties, whereas in reality uncertainties significantly contribute to the outcomes of the policy. For example, as PLN financial conditions may vary during the power plant concession period, and the government guarantees the financial condition, the government needs to assess the uncertainties. Secondly, the current model generically incorporates all types of power plants. The outputs of the model, therefore, provide general guidelines, which may not be the most suitable ones for the renewable energy sector. The current proposal posits that to understand accurately and predict the precise outcomes of policy alternatives, the simulation model should incorporate the characteristic features of the renewable energy power plants.

Therefore, this study will further contribute by providing a practical fiscal risk management tool for the government in the form of a stochastic simulation model for renewable energy power plants. This tool can be used for analysing guarantee proposals, to estimate fiscal risk and economic impacts of the guarantees, and to design fiscal risk control policies.

This research constructs a simulation model to assess fiscal risks associated with the government renewable energy incentive schemes. This model consists of three sub-models: PLN, power plants, and macroeconomics. The PLN submodel simulates PLN's financial condition, the power plants submodel simulates the power plants' technical and financial conditions, and the macroeconomic submodel simulates impacts to the national budget.

1.9 Organisation of Thesis

The objective of the thesis is to simulate the impact of the Business Viability Guarantee and Debt Guarantee for renewable energy at both project level and country level. At a corporate level, it shows the impacts on the project cost and profitability, whereas at the national scale, it presents the consequences for the government. In this thesis, the background of the study will be described followed by a literature review. This is followed by data analysis to answer the research questions. Based on the data finding, implications for the government will be discussed. This thesis consists of five chapters as follows.

Chapter 1 provides a background to the research, including the important of infrastructure development (particularly geothermal power plants), electricity needs, the role of PLN and IPPs, government guarantees and the consequences to fiscal risks. It also defines the research problems and research hypothesis. A conceptual framework to address the research problems and research hypothesis also presented followed by research contributions and significance of the research.

Chapter 2 presents the literature review of previous research related to this study. It offers a literature review of Public-Private Partnership, including its definition, benefits, investor perceptions, the available government supports (especially for renewable energy development) and the fiscal risk involved. As fiscal risk involves uncertainties, this chapter also explains the literature regarding uncertainties and how to assess it with the Monte Carlo Simulation, followed by an outline of past studies and models to quantify fiscal risk for infrastructure projects.

Chapter 3 details the research framework to answer each of the research question and presents the research data. It explains how to quantify fiscal risk, including assessing risk probability and impact, which defines the level of risk. Next, a method to minimise fiscal risk will be illustrated.

Chapter 4 investigates the first simulation model developed in this study, which examines PLN's income statement for 2018 and 2019 to understand PLN's condition before any additional geothermal power plant is developed. The framework of the simulation model, in general, will be illustrated and a method to forecast several items in an income statement will be presented. This includes how to project revenue items, such as the sale of electricity, connection fee and other revenue, operating expenses, non-operating income (loss), and electricity subsidy. Historical data for each independent variable is also analysed in this chapter to understand their pattern, and behaviour. After inputting these data, the simulation result will be presented at the end part of this chapter.

Chapter 5 explains the second simulation developed for this study, which is the Business Viability Simulation. This model is intended to examine financial impacts for PLN when purchasing electricity from geothermal projects owned by IPPs, both on the revenue and cost sides. In this chapter, the framework of this model to estimate any additional revenue and cost will be explored. This model is then implemented in relation to seven geothermal projects which received Business Viability Guarantees from the government of Indonesia.

Chapter 6 explores the last model of this study, the Debt Guarantee simulation model. It analyses the financial impact for PLN when it developed geothermal power plants and acquired project loans to finance the project, and as a result, the lenders received a Debt Guarantee from the government. In this scheme PLN was exposed to geothermal development risks. These risks are considered in this model, particularly in the cost items. Furthermore, the model framework includes a model to assess the revenue of cost, which will be explained and implemented in relation to three geothermal projects owned by PLN; the Ulumbu, Mataloko, and Atadei geothermal projects. Simulation results for these projects will be presented as summaries in the last section of the chapter.

Chapter 7 summarises and compares results from Chapters 4, 5, and 6 to estimate the fiscal impact. In this chapter, research questions will be addressed, followed by a discussion of the results.

Chapter 8 presents a summary of this thesis. Research findings and the research problem will be compared. This is followed by debate on the policy implications and recommendations derived from the results, the contribution and the limitations of the study, and suggestions for future research.

1.10 Chapter Summary

In this introductory chapter, the benefit of infrastructure development, including the benefit of private sector participation in infrastructure delivery and particularly geothermal power plants, was pointed out. The chapter has outlined the background to this research, the research problem and research hypothesis. Next, a conceptual framework to answer the research problem and research hypothesis was presented. It also justified this study by explaining its research contribution both in terms of academic and practical contributions. In the end section, the organisation of the thesis was disclosed. The following chapter will describe literature reviews related to this study.

Chapter 2
Review of Literature

2.1 Introduction

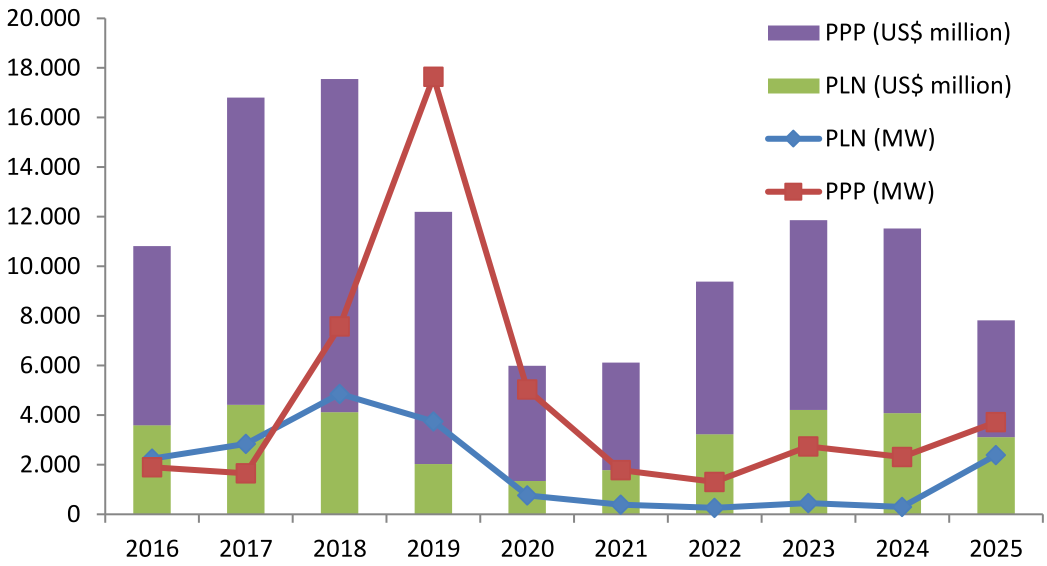
The previous chapter explained the benefit of engaging the private sector in geothermal development, as well as outlining the scope of this study. The background to this research, the research problem and research hypothesis were explained as well as the conceptual framework and justification for this study. This chapter will explore relevant literature related to public and private sector cooperation in delivering infrastructure including its benefits and risks. Methods to assess risk and uncertainties will also be explained together with a presentation of samples of their implementation in past studies, along with their model and variables, especially for the case of the Indonesian geothermal sector.

2.2 Public Private Partnership (PPP) in the geothermal sector

Geothermal power plant development in Indonesia can be conducted by the public sector (PLN) or private sectors (IPPs). When IPPs develop the power plant, they cannot directly sell the electricity to retail customers, they are only able to sell the electricity to PLN as the only electricity retailer to households in Indonesia. This cooperation is under a Public Private Partnership (PPP) scheme. In Indonesia PPP occurs not only in the power generation sector but also for other infrastructures. The Indonesian Ministry of National Development Planning / National Development Planning Agency (2015) estimates that of the total infrastructure funding needs in 2015-2019, the government will only be able to fulfil 30% of it. The government will only have approximately Rp 1,433 trillion out of Rp 4,796 trillion. It is expected that private investors can contribute around 36% of the funding gap, so the government aims to put more infrastructure projects in the PPP scheme. The Indonesian PPP Book 2013 offered 27 projects, while in the 2015 version, the number of projects increased to 38 (Ministry of National Development Planning / National Development Planning Agency 2015). Particularly for power plant development, it is expected that the PPP's power plant development will exceed traditional procurement in terms of project investments and power plant capacity. Figure

2.1 compares the Indonesian power development plan between PPPs and traditional procurement for the period 2016-2025.

Figure 2.1 Power plant development program, 2016-2025



Source: PT Perusahaan Listrik Negara (Persero) (2016d).

2.2.1 Definition of PPP

There is no single definition of PPP. The European Commission (2003, p. 128) defines PPP as "the transfer to the private sector of investment projects that traditionally have been executed or financed by the public sector". Hemming (2006, p. 1) refers to PPP as "arrangements under which the industry supplies infrastructure assets and infrastructure-based services that traditionally have been provided by the government". The Australian Government (2008, p. 7) interprets PPP as "a long-term contract between the public and private sectors where the government pays the private sector to deliver infrastructure and related services on behalf, or in support, of government's broader service responsibilities". The World Bank, ADB and IDB (2014) view PPP as:

> A long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risks and management responsibility, and remuneration is linked to performance.

Meanwhile, President of the Republic of Indonesia (2015) defines PPP as:

the cooperation between government and Business Entity in infrastructure provision for the public interest in accordance with the specification previously determined by the Minister/Head of Institution/Head of Region/State Owned Enterprise/Regional Owned Enterprise, which partially or entirely uses Business Entity's resources, with particular regard to the allocation of risk between the parties.

There are several features of PPP (Australian Government 2008; European Commission 2003; President of the Republic of Indonesia 2015):

1. **Purchasing services**. In PPP the focus is not on procuring assets but purchasing services. Rather than mentioning the assets' specifications, the contracts talk about specific service quality and quantity and timeframe.
2. **Payment for services.** The government or users pay for the services once the infrastructure is commercially operational. If a service fails to be provided on time or fails in fulfilling the agreed quality or quantity, the private sector may be penalised.
3. **Risk sharing.** Risks are shared between the government and private sectors.

There are several differences between traditional procurement and PPPs. In the case of geothermal power plant development, for example, in traditional procurement, the government or PLN find a geothermal consultant to do a preliminary geothermal study including geophysics, geochemical, and geological (3Gs) studies to find the best geothermal well location. Afterwards, PLN finds a drilling company to make geothermal wells and an Engineering, Procurement, and Construction (EPC) company to construct the power plant. PLN has to prepare all the financial needs and it also responsible for maintaining and operating the power plants. On the other hand, when a PPP scheme is implemented, PLN finds an IPP which will be responsible for doing all of those activities, and the responsibility of PLN is to purchase the electricity from the IPP at a specified volume and period. More detail about the differences between traditional procurements and PPP are presented in Table 2.1 below.

Table 2.1 Differences between traditional procurement and PPPs

Traditional Procurements	PPPs	Advantages of PPP
Government purchases an infrastructure asset	Government purchases infrastructure services	Quality of the services are more controllable
Short-term design and construction contracts (two to four years)	One long-term contract integrating design, build, finance and maintenance	Risk sharing between government and private sector
Input-based specifications	Output-based specifications	More controllable output
Government retains whole-of-life asset risk	Private sector retains whole-of-life asset risk	Risk sharing between government and private sector
Payment profile has a spike at the start to pay for capital costs, with low ongoing costs	Payments begin once the asset is commissioned. The payment profile is relatively even, reflecting the level of service provision over the longer term of the contract	Answers the financial problem in infrastructure development
Government is usually liable for construction time and cost overruns	Private contractor is responsible for construction time and cost overruns	Risk sharing between government and private sector
Government operates the facility	Government may or may not operate the facility	More options for the government
Government manages multiple contracts over the life of the facility	Government manages one contract over the term of the facility	Simpler
Often no ongoing performance standards	Performance standards are in place. Payments may be abated if services are not delivered to contractual requirement	The government has more bargaining position
Handover quality less defined	End-of-term handover quality defined	More certain on the handover quality

Sources: Australian Government (2008, p. 10) and the author.

2.2.2 Benefits of PPP

Aside from having several advantages over traditional procurements, PPP also delivers several benefits, such as:

1. It provides additional sources of funding and financing, better planning and project selection, bringing a more efficient and effective public service, improved

maintenance and improved government capacity and governance (Ministry of National Development Planning / National Development Planning Agency 2015; World Bank, ADB & IDB 2014).

2. It can overcome project cost overruns and delays (Sarmento 2010; Siemiatycki 2009).
3. It potentially delivers better quality of services and cost (Australian Government 2008).
4. It stimulates better cooperation between the public and the private sectors, improves risk management, creates greater transparency on government policies, identifies critical success factors clearly, and provides better contract and financial analysis (Tang, Shen & Cheng 2010).
5. It can transfer knowledge and experience in the development, operation, and management of infrastructure to the public (Ministry of National Development Planning / National Development Planning Agency 2015).
6. It has potential to deliver higher value for money (VFM) over the life of the projects since the government can transfer some of the risks to the private sector (Ball, Heafey & King 2007; Grimsey & Lewis 2005; Sarmento 2010; Shaoul 2005; Tanaka et al. 2005).

PPP projects need to create value for money for the public sector (Ball, Heafey & King 2007; Morallos & Amekudzi 2008; Sarmento 2010). VFM compares whether projects will deliver services more effectively and efficiently under a PPP scheme or traditional procurement (Ball, Heafey & King 2007; Coordinating Ministry of Economic Affairs 2010) over the concession period through the Public Sector Comparator (PSC) method (Michael Regan 2014). Therefore, VFM analysis is mandatory in Indonesian PPP (President of the Republic of Indonesia 2015). VFM, however, requires a fair degree of risk sharing between the public and private sectors (Grimsey & Lewis 2007). Insufficient risk transfer to the private sector can make the project inefficient. Meanwhile, if the risks are transferred to the private sector excessively, the VFM will decline (Morallos & Amekudzi 2008).

2.2.3 Investors' Perception of Infrastructure Business

When investing in infrastructure sectors including in geothermal projects, investors also seek other factors than VFM, and they also find the profitability of the projects. Investment will also depend on the investor's perception of the business. Blanc-Brude, Chen and Whittaker (2016) conducted an in-depth survey of institutional investors' perceptions and expectations of infrastructure investment and found that investors have over liquidity, and they are worried about increasing their uninvested money (dry powder). Most of them, 65%, are willing to invest in infrastructure projects in the next 3-5 years. Their primary reason for investing in infrastructure is because such projects are more convenient to have as a long-term investment. Most of them, 81%, expect to hold an investment for at least ten years.

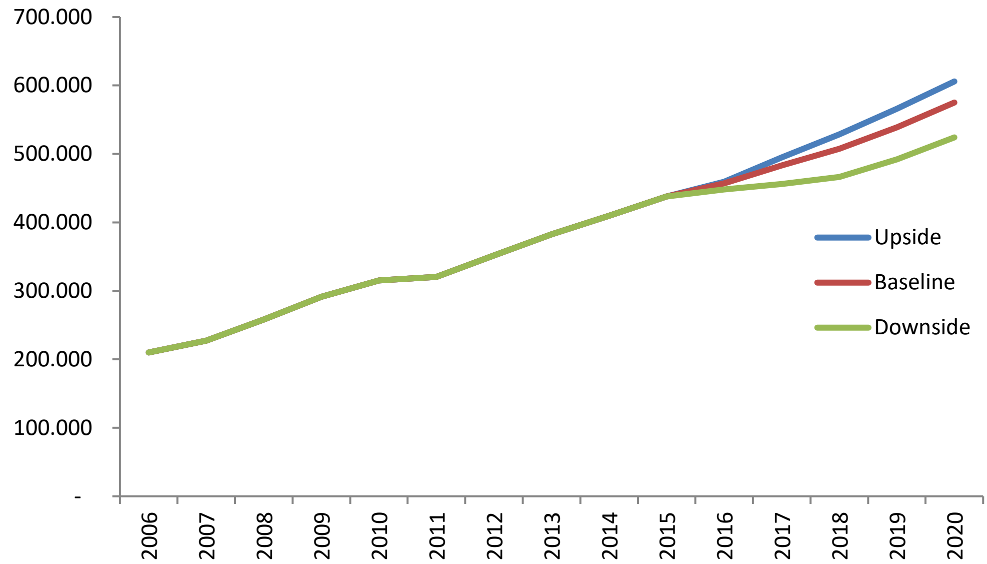
However, according to the survey, investors think that only small numbers of infrastructure investments are attractive. There are some features that define the attractiveness. The most important thing is the stability of the regulatory and contractual framework. The second most important is earning stability and then counter-party risk.

Furthermore, only 20% of investors are investing in emerging markets, but 33% of them are willing to invest in these markets for the first time. To attract more investment in the markets, they suggest that the emerging markets should focus on creating bankable projects. The projects need regulatory, contract and revenue stability to be bankable. Therefore, governments need to minimise political risks and counterparty risks.

For the government, investments in the infrastructure projects are necessary, even in the economic downturn. In the recession, PricewaterhouseCoopers (PwC) suggests constructing more transport networks and building more utilities as they create jobs and economic activity (Oxford Economics 2016). In an upturn economic scenario, Oxford Economics (2016) calculated that the most definite beneficiary is the Asia Pacific region with utilities and the transport sector leading the way transport sectors. The sectors are forecasted to have the highest economic activity and investment.

Regarding the utility sector, Oxford Economics (2016) estimates that spending will increase no matter the economic conditions. In an economic downturn, for the period 2014-2020, spending is estimated to increase almost 30%. Meanwhile, in an economic upturn, it is predicted to increase by almost 50% (see Figure 2.2). Therefore, investment in the utility sector in the Asia Pacific is promising for investors and governments.

Figure 2.2 Trends in annual utility infrastructure spend in the Asia Pacific region, 2006-2020, (in USD million)



Source: Oxford Economics (2016).

The limited budget of government for developing infrastructure on one side, and the increasing level of dry powder and the promising utility business in the Asia Pacific, on the other hand, can create a synergy between the public and private sectors. This synergy can be conducted in the form of a Public Private Partnership (PPP) scheme.

The limited budget makes governments prioritise their spending for their basic needs including health, education, and basic infrastructure where the private sector is not interested in developing these. Private sector solutions become a reasonable means to develop infrastructures, particularly for the energy sector (Granoff, Hogarth & Miller 2016). This crowding-in private finance scheme has been succeeding around the globe. For example, the UK government has been reorienting its financing strategy for a large-scale investment in energy efficiency from government spending to private finance (Bergman & Foxon 2018). In the developing world, several countries also have been attracting private sector participation such as Egypt and Myanmar for power projects, Columbia for road projects, and Turkey for healthcare projects (Committee 2017). In Indonesia, this scheme has also been implemented for several projects such as development of the Central Java Power Plant, the most massive power plant in Southeast Asia (Safitri 2015), toll road developments (Wibowo & Kochendoerfer 2011), the

Umbulan Water Supply project, and the Jakarta Soekarno Hatta – Manggarai airport rail link (Asia Today International 2013).

Bergman and Foxon (2018) highlight the government's role to reduce investment risk so that more investor will come. Reducing risk can be applied by risk sharing mechanisms such as by providing guarantees (Granoff, Hogarth & Miller 2016; Sidlo 2017). Guarantees can be provided by a multilateral agency such as World Bank's Multilateral Investment Guarantee Agency (MIGA), development banks, or governments as support for infrastructure development.

2.2.4 Government Supports for Infrastructure Development

In business, usually, the private sector is looking for profits. Therefore, the PPP projects need to be feasible. To ensure their feasibility, the government offers viability gap funding (Ministry of National Development Planning / National Development Planning Agency 2015). Feasibility support will be given by the government in the form of cash, as a portion or a whole of the construction cost (Menteri Keuangan Indonesia 2012b).

Furthermore, to enhance the partnership and to attract more private sector participation, the government needs to provide government support (Carbonara, Costantino & Pellegrino 2014; Cheah & Liu 2006; Maskin & Tirole 2008) such as government guarantees (Badu et al. 2013; Chan et al. 2010; Hemming 2006; Karyadi & Marseille 2010; Lucas & McDonald 2010; Takashima, Yagi & Takamori 2010; Wibowo et al. 2012). Therefore, the government provides political guarantees for PPP projects, including for power sector. This policy implies that the government guarantees any government actions or inactions which can disrupt the power plant development (Menteri Keuangan Indonesia 2010b; The President of the Republic of Indonesia 2010b).

Huang and Wu (2008) argue that the electricity sector suffers from the risk of primary energy price volatility, which may lead to a high generation cost, so government incentives are necessary to reduce this cost. In Indonesia, the government provides debt guarantees and business viability guarantees. According to the debt guarantees, the government ensures that PLN will always be able to pay its debts (The President of the Republic of Indonesia 2006, 2007, 2009b). Meanwhile, based on the Business Viability Guarantees, the government guarantees that PLN's financial condition (as the electricity off-taker from IPPs) will always be viable to pay the purchased electricity from the IPPs (Menteri Keuangan Indonesia 2011b; The President of the Republic of Indonesia 2010a).

2.2.5 Incentive Renewable Energy Development

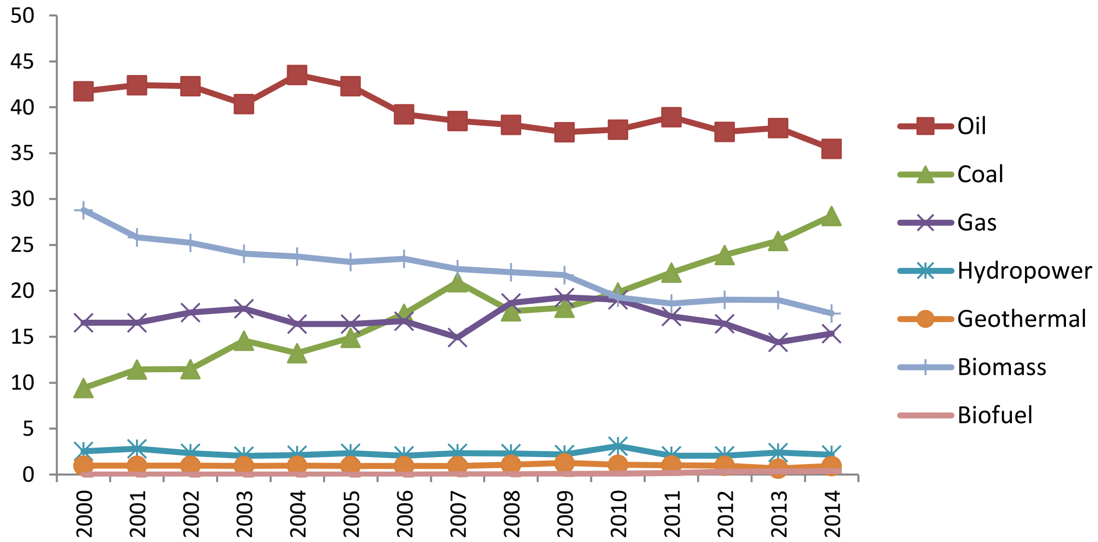
In particular for renewable power, Huang and Wu (2008) argue that in the long term, putting in more renewable energy power plants would reduce the national generation cost. However, Wüstenhagen and Menichetti (2012) found that fossil fuels have a lower generation and investment cost than renewable energy power plants. Meanwhile, after examining Indonesian electricity data from 1997-2009, Hasan, MH et al. (2012) concluded that during that period, Indonesia developed more fossil fuel than renewable energy power plants because of their cost advantages. Therefore, to accelerate renewable energy development in Indonesia, the government need to reduce this cost. In Indonesia, the government provides fiscal incentives including direct and indirect tax facilities as well as free import tariffs for capital goods and machinery for the renewable energy power plants (Menteri Keuangan Indonesia 2010a). Furthermore, as geothermal businesses have a costly exploration risk, the government takes the risk by funding the first three exploration wells (Menteri Keuangan Indonesia 2012a). The Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) found that this risk funding can significantly reduce geothermal costs in Indonesia so it may attract more IPPs.

These incentives to lower the cost of renewable energy development are important as renewable energy companies are often among the riskiest types of companies to invest in (Sadorsky 2012). In emerging markets, the risk varies depending on government efforts to encourage the deployment of renewable energy (Donovan & Nuñez 2012). The higher the return, the higher also the risk. For example, photovoltaic gives the lowest risk but also the lowest return. Meanwhile, wind and mini-hydro have a higher risk and higher return (Muñoz et al. 2009). The risk can be reduced by implementing the Clean Development Mechanism (CDM) but it has drawbacks (Schmidt, Blum & Sryantoro Wakeling 2013) and will not be sustainable in the long run (Zavodov 2012). According to the Deputy Assistant for Climate Change Impact Control Ministry of Environment Indonesia (2006), there are some renewable energy projects which participate in CDM, for example, PT Multimas Nabati Asahan and PT Murini Sam Sam for their biomass projects, and PT Chevron Geothermal Ltd for its geothermal project.

Regardless of the risks, Bhattacharya and Kojima (2012) found that renewable energies are more competitive than conventional, fossil fuel energies because they can compensate some risks associated with the total input costs, such as volatilities of fossil fuel prices, capital costs, operating and maintenance costs and carbon costs. Simulation results also show that replacing fossil fuel with renewable energy helps reduce generation cost. However, renewable energy will only play a more significant role in electricity generation regarding unit capacity and conversion efficiency (Huang & Wu 2008).

Regardless of the benefits of renewable energy, overall, the proportion of renewable energy generation in Indonesia is declining (see Figure 2.3). The primary contributing factor is the diminishing generation of biomass power. Other renewables, however, are hovering with no visible, rapid development.

Figure 2.3 Supply of primary energy in Indonesia, in percentage, 2000-2014

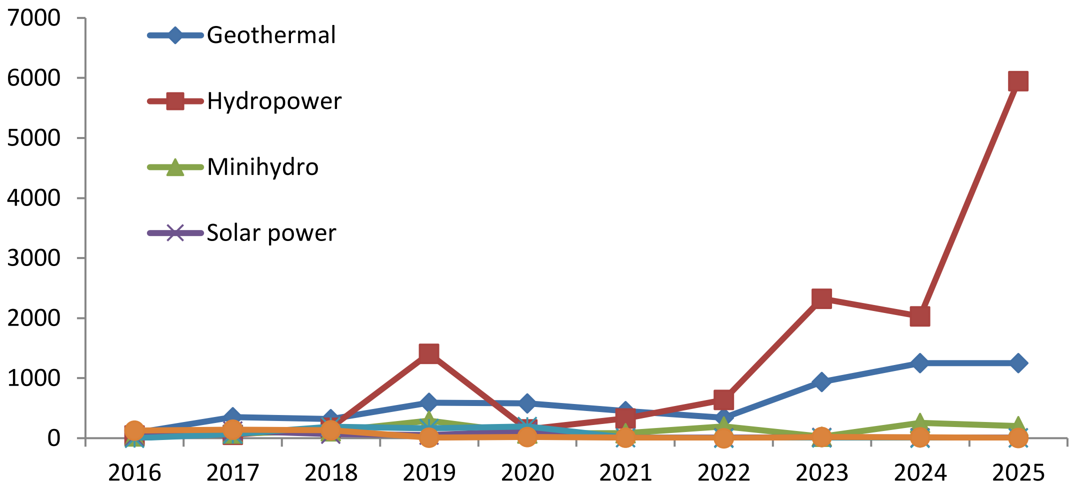


Source: Center for Data and Information Technology (2015).

Also, Indonesia has committed to reducing its GHG emissions. The energy sector is the most massive GHG emitter, and the biggest emitter is power generation (Ministry of Environment Indonesia 2010). So, to achieve the target, Indonesia needs to focus on GHG emission reduction from electricity generation. However, Indonesia cannot reduce electricity generation as it currently faces the prospect of an electricity shortage (PT. PLN (Persero) 2015). Therefore, the effective way to decrease these emissions sustainably is by reducing them on the supply side. These options include, among others, substitution of fossil (high carbon content) fuels with renewable (zero carbon content) energy (Timilsina & Shrestha 2006) and developing more renewable energy (Purwanto et al. 2015). Developing renewable energy power plants can supply additional power without adding more GHG emissions.

Considering the benefits, the government plans to develop more renewable energy power plants. The plans include increasing the renewable energy development portion of the electricity fuel mix to become 23% in 2025 and 31% in 2050. It also limits oil, coal and gas power generation to a maximum of 25%, 30% and 22%. By 2050, the proportion must be a maximum of 20%, 25% and 24%, respectively (President of the Republic of Indonesia 2014b). Therefore, to achieve this goal, the government is focussing on hydropower and geothermal development (see Figure 2.4).

Figure 2.4 Renewable energy development plan, in MW for 2016-2025



Source: PT Perusahaan Listrik Negara (Persero) (2016d).

However, geothermal exploration, to find its resource, is risky (Akar & Young 2015). It is also high risk regarding drilling, exploration, and operation and maintenance (Sanyal & Yasukawa 2013). However, the government has the initiative to take the risk by establishing a Geothermal Fund Facility (GFF) to reduce the drilling and exploration risk (Menteri Keuangan Indonesia 2012a).

2.2.6 Fiscal Risk Management

The government provides government guarantees to attract more investors. Such assurances are common in public-private partnership projects (Takashima, Yagi & Takamori 2010). However, it creates a government obligation (Hemming 2006) hidden in the form of contingent liabilities (Brixi & Schick 2002). It can also create significant liability for the government (Irwin 2007) and increase implicit liabilities; that is, non-contractual liabilities from moral obligation or public expectation (Ter-Minassian 2005). As a consequence, the government will be exposed to an additional fiscal risk (Ter-Minassian 2005).

Fiscal risk refers to the probability of material differences between planned and actual fiscal performance (Kopits 2014a) over a short-term and long-term period (Kopits 2014b) because the government cannot meet its targeted revenue or expenditure (Ramadyanto 2012).

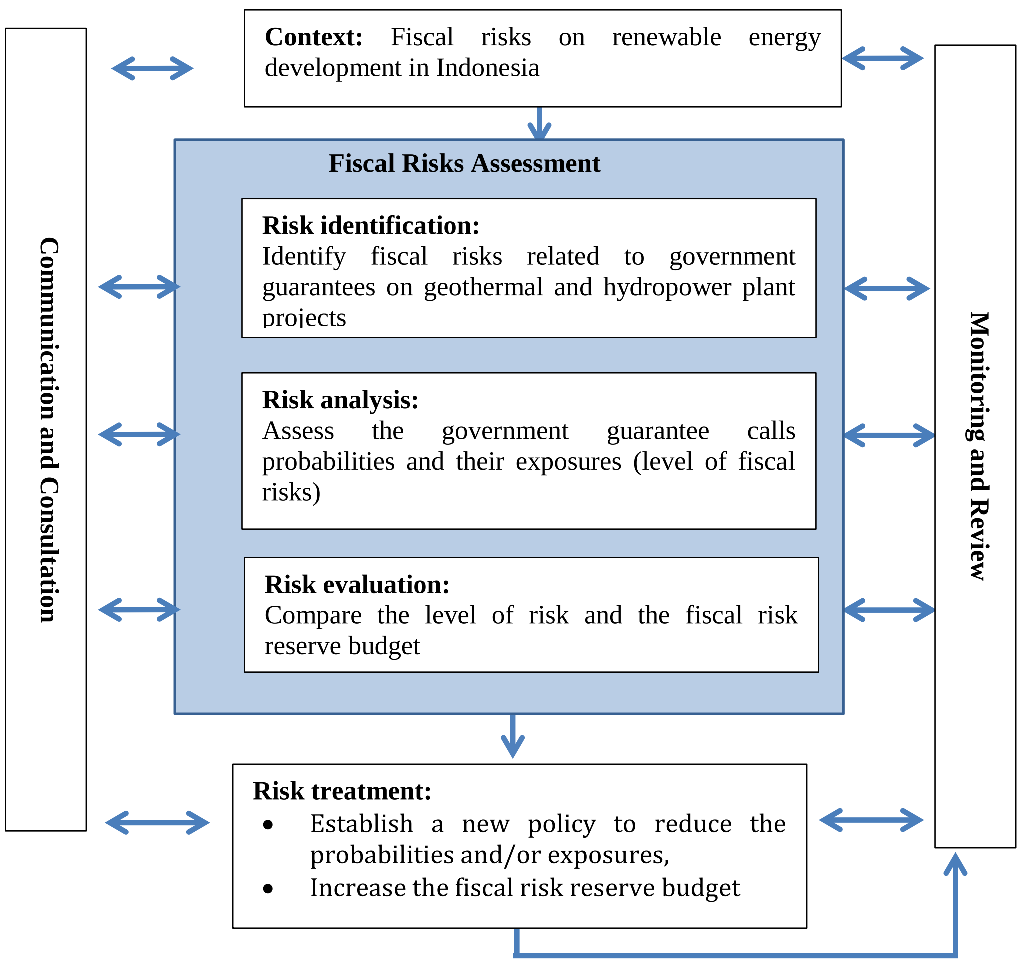
According to Polackova (1999), Brixi and Schick (2002), and Brixi and Mody (2002), a fiscal risk can be direct or contingent. It is direct if the obligation is accurately predictable, and it is contingent if it is uncertain. Further, it is explicit if it is created by regulation and, therefore, it is legally binding, and it is implicit if it is not legally binding. The risk should be managed to ensure the fiscal sustainability.

Fiscal risks might lead to sovereign risk which means the economy becomes weaker (Corsetti et al. 2013). The main source of the risk are political factors, including expropriation risk, the fiscal position (high deficits and debt, higher default risk), fiscal space, the proportion of capital spending in the budget, fiscal risk measures, fiscal discipline (or previous default history), business climate factors (Baldacci, Gupta & Mati 2011), government guarantees on the infrastructure projects (Hemming 2006; Ter-Minassian 2005), and contingent fiscal liabilities (Polackova 1999).

Risk, according to *AS/NZS 4360 Risk Management Standard*, is "the chance of something happening that will have an impact on predefined objectives". The severity of risk is assessed based on its likelihood and consequences. Meanwhile, instead of putting more emphasis on the chance, *ISO 31000 Risk Management Standard* highlights the uncertainty factor and defines risk as "the effect of uncertainty on objectives" (Aven 2011). Both standards define risk as positive and negative consequences. However, Hopkin (2013) argues that risk should have negative impacts.

Figure 2.5 illustrates the current risk management framework under ISO 31000 adopted for the current study, which used this standard to analyse the fiscal risks associated with renewable energy development in Indonesia. This study will adopt this standard to analyse the fiscal risks associated with renewable energy development in Indonesia. The fiscal risk management process comprises establishing the context, risk identification, risk analysis, risk evaluation and risk treatment. During the process, communication and consultation, as well as monitoring and review, are conducted (International Organization for Standardization 2009; Standards Australia/Standards New Zealand 2009). The process, from risk identification, risk analysis until risk evaluation, is also known as risk assessment (International Organization for Standardization 2009; Standards Australia/Standards New Zealand 2009; Tanaka et al. 2005).

Figure 2.5: Fiscal risk management process



Adapted from Risk Management Process in ISO 31000

Risk assessment comprises estimating risk probabilities and exposures (International Organization for Standardization 2009; Standards Australia/Standards New Zealand 2009). Regarding government guarantees, the probabilities and exposures are uncertain (Doan & Menyah 2013; Ryan, J 2012; Sfakianakis & Laar 2013). Therefore, Wibowo et al. (2012) suggest a Monte Carlo simulation method to predict these uncertainties.

2.3 Uncertainties and Monte Carlo Simulation

Uncertainties and risks are closely related. Risk assessment and uncertainties are essential in decision making (Broadbent, Gill & Laughlin 2008). Risks come from uncertainties (Aven 2011; Froud 2003; Gzyl & Mayoral 2010; Paul 2014). However, they are not always recognised and considered in decision processes (Acebes et al. 2014). Moreover, regarding renewable energy projects, they involve greater uncertainties as they are deemed long-term planning with environmental constraints (Parkinson & Djilali 2015). To address this uncertainty, a Monte Carlo simulation is often conducted by researchers (Brandimarte 2014; Farid 2013; Kroese, Taimre & Botev 2013; Manly 2008; Molak 1996; Vose 1996; Yoe 2012). For example, the simulation helps to quantify the effects of risk and uncertainty of infrastructure projects (Kwak & Ingall 2007) and government guarantees (Carbonara, Costantino & Pellegrino 2014).

The Monte Carlo simulation generates a random number series to estimate a deterministic quantity to create scenarios, to find the best policy option and to evaluate the policy performance (Brandimarte 2014). A randomly generated number can be used to estimate model output(s) variables (Manly 2008; Yoe 2012). In general, there are five basic steps for Monte Carlo modelling (Manly 2008, p. 249):

1. Setting up a model to describe the real situation;
2. Assuming probability distributions for input variables;
3. Defining output variables;
4. Generating random values in the input variables, resulting in output values; and
5. Summarising the output distributions by statistics.

Regarding infrastructure projects, a Monte Carlo simulation can help to estimate the outputs and outcomes of the projects. Some examples of Monte Carlo simulation applications are the estimation of the government guarantee value for the Malaysia-Singapore Second Crossing (Cheah & Liu 2006), the estimation of contingent liabilities from government guarantees in Indonesian toll road projects (Wibowo et al. 2012) and the estimation of technology options for long-term energy planning (Parkinson & Djilali 2015).

A simulation model usually uses a spreadsheet to simulate the effects of various inputs on the outputs. However, traditional spreadsheets including Microsoft Excel are only able to change one cell at a time, so it is hard to understand the total possible impacts on the outputs. It also only provides single point estimates which only tell the possibility without presenting the probability. To overcome that limitation, the model and simulation in this study use the Monte Carlo Analysis with the help of Crystal Ball software. Instead of using a single-point estimate, Crystal Ball displays results in a forecast chart showing all possible outcomes together with the likelihood of achieving each of them (Oracle Help Center 2017). Random numbers generated in a Monte Carlo simulation follow certain probability distributions. In the financial model, the distribution of a variable is derived from either literature or after examining the histogram of its historical data (distribution fitting).

2.4 Past Studies

Indonesia's commitment to reducing greenhouse gas emissions has led Yusuf et al. (2010) to simulate several possible fiscal instruments that might be imposed by the government and then assess the effectiveness of the policy in reducing the emissions. They identified that the most significant greenhouse emitter is energy consumption, especially fuel, so they simulated two measures to decrease fuel consumptions which were eliminating fuel and electricity subsidies, and imposing a carbon tax. For their study, they constructed a computable general equilibrium (CGE) model incorporating renewable energy, including geothermal and hydropower.

They found that the elimination of fuel subsidies will reduce emissions by 5.79 % in the long run and 1.71% in the short run. Meanwhile, the electricity subsidy can reduce CO2 emission by 0.92% in the long run and 1.24% in the short run. However, in the short run, the GDP might fall by around 0.5%, and the employment rate might also decline by 1.08%. Furthermore, household consumption will also decrease for rural and poor households, poor and non-poor households. The elimination of the subsidy will benefit government as the government has to save from the subsidy budget, but both in the long and short run, the government will suffer from smaller revenue on indirect tax, import tax, household income tax, and corporate income tax.

Indonesia has been imposing these taxes, so Yusuf et al. (2010) simulated a carbon tax of USD 2.80 per ton of CO2. As a result, in the long run, emissions will be reduced by around 7.36% and in the short run around 6.94%. If this policy is combined with the elimination of fuel and electricity subsidies, in the long run, emissions will fall around 14% while in the short run they will drop almost 10%. This policy will have a slight impact on the Indonesian GDP. Regarding fiscal impact, the carbon tax will increase government revenue around IDR 8.1 – 9 trillion (in the long run) and around IDR 8.1 – 9.6 trillion (in the short run), but the government will suffer a loss in indirect tax, import tariffs, household and corporate income taxes. Even, if the application of income tax is combined with the abolishment of fuel and electricity subsidies, tax revenue will decline twice because of the carbon tax revenue. Moreover, the carbon tax implementation will increase the unemployment rate in the short run.

Overall, Yusuf et al. (2010) have assessed fiscal impacts, including impact to the government revenue and expenditures, from two possible fiscal instruments with a deterministic model. They also did not quantify the probabilities of the fiscal impacts, so their study has not measured any fiscal risk yet. The research also fails to demonstrate the impact to the renewable energy companies.

From the renewable energy company point of view, Sadorsky (2012) investigated the risk determinant of renewable energy risk using a beta model based on the capital assets pricing model (CAPM). He also used a panel data regression method to find the relationship between market risk and the stock price of renewable energy companies. A Monte Carlo simulation was also conducted to examine the impact of the uncertainty of sales growth and oil price on the beta value.

He found that renewable energy companies have a beta value of around 2, meaning that the renewable energy company stock price is very sensitive to the market. Any move in the market leads to renewable energy stock price movement in the same direction but with twice the impact. When the market moves 1%, the renewable energy stock price moves 2%. The main finding of Sadorsky’s research research is that the growth of company sales can lower systematic risk but a moderate increase in oil price returns has the opposite impact and can increase systematic risk. Based on the Monte Carlo simulation, oil prices have an impact on beta higher than sales growth. The simulation also proves that debt to equity ratio, firm size, and research and development expenditures do not have any significant impact on beta. Factors that have the most significant impact are market returns, followed by oil prices and sales growth.

Sadorsky (2012) suggests government intervention to reduce the systematic risk by creating a specific demand for renewable energy through government regulation to ensure consumers buy more renewable energy or the government directly buying renewable energy. Other ways to increase the sales growth can be done by implementing feed-in tariffs, subsidies, renewable energy portfolio standards, fossil fuel consumption taxes and carbon taxes. Sadorsky's research research provides insight into renewable energy company risk, but it only focuses on the stock price risk without acknowledging any other risks such as operation risk, interest risk and any other business risks. Government interventions are also suggested, but the research does not describe the fiscal impact or risk as the consequences of the government policies.

There is research conducted by Sun and Zhang (2015) that examined the impact of government policy in the form of government guarantees. They investigated the optimum minimum revenue guarantee (MRG) level, and royalty collection rate for a wastewater treatment project in China under a build, operate, transfer (BOT) PPP scheme. Their model combines a revised net present value (NPV) and Monte Carlo simulation to find the optimum value from the investors' and government's perspectives. It was found that MRG for 90% volume combined with a royalty rate of 20% offers the best option. This scenario allows the investor to earn a reasonable return, and shortens the payback period. Their research incorporates capital and operating costs of a concessioner and probability distribution for the uncertain parameters to be considered but is only applicable for MRG for a wastewater project in China and does not calculate fiscal risk from the guarantee policy.

Regarding fiscal risk assessment, the International Monetary Fund and World Bank Group (2016) created a generic Microsoft Excel-based model to measure fiscal cost and risk for PPP projects, named the PPP risk assessment model (PFRAM). In detail, this model provides construction risks, demand risks, operational and performance risks, financial risks (including guarantees), force majeure, material adverse government actions, change in the law, rebalancing of financial equilibrium, renegotiation and contract termination. Each risk category is measured by its impact on government deficit, balance sheet, and cash deficit. However, this model only accounts for contingent liabilities from debt guarantees and minimum revenue guarantees, while a business viability guarantee is not yet taken into account.

Indonesia has been providing guarantees for toll road projects. Wibowo et al. (2012) quantify contingent liabilities from government supports to PPP toll roads in Indonesia including land-capping policy to protect toll road investors from skyrocketing land costs, periodic toll adjustment, and a guarantee that there will be no asset nationalisation. They conducted a 10,000 iteration Monte Carlo simulation to answer their research question. It was found that the Indonesian risk budget for land-capping was sufficient to cover the fiscal risk exposure, but it was not adequate to cover the toll delay and nationalisation risks so the government should keep its promise to adjust the toll every two years and not nationalise the toll roads. This study is only applicable to toll road projects in Indonesia and is not appropriate to calculate fiscal risk from the energy sector, particularly in relation to geothermal power plant projects.

A study about fiscal incentives to accelerate private sector participation in geothermal energy development in Indonesia was initiated by the Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009). This study intended to find optimal fiscal incentives to attract more investment in geothermal energy development. The researchers used a Monte Carlo simulation to model a coal-fired power plant and a geothermal power plant. The coal power plant model was made as a profitability benchmark of the geothermal power plant as they believed that the private sector will be interested in developing geothermal energy in Indonesia if the geothermal project at least provides a similar Financial Internal Rate of Return (FIRR) as that promised by the coal power plant. They found that accelerating geothermal development can reduce PLN generation cost, increase export of coal, increase tax revenues, is better for the environment, stimulates the economy, and increases the employment rate. In order to get those benefits, they recommend the government implements a Feed-in Tariff (FIT) scheme by obliging PLN to purchase power from renewable energy sources at fixed prices. The fixed price can be a particular ratio (e.g. 85%) of the retail electricity tariff or a fixed price (e.g. USD 10 cents/kWh) for geothermal electricity. They also recommend the government set a proportion of renewable energy in the total power generation mix by imposing a RPS (Renewable Energy Portfolio Standard) scheme. To reduce the geothermal cost, the government also needs to apply tax incentives with preferential treatment to geothermal projects in terms of construction subsidies, governmental geothermal surveys in the early stages (including a surface survey and an exploratory drilling survey), and financial incentives in the form of low-interest loans, the Clean Development Mechanism (CDM), and a Carbon Tax.

This study provides in-depth financial modelling for a geothermal power plant project, incorporating geological and business risks combining deterministic and probabilistic inputs and outputs. However, it focuses on the project and does not put more emphasis on fiscal impacts from the proposed government incentives discussed above.

Later, Castle Rock Consulting (2010) also did analysis on geothermal costs using a combination of the probabilistic and fixed model with a Monte Carlo simulation. It found that geothermal projects should be developed under the PPP scheme. The results of this study, among other things, include a probability distribution of crucial geothermal resources, technology costs, and financial parameters, which reflects the uncertainties in the parameters that determine the production costs of a geothermal power plant. This data is essential to model a probabilistic geothermal power plant project.

Asian Development Bank and The World Bank (2015) continued the work of Castle Rock Consulting (2010); Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) through further research on geothermal cost analysis and by updating cost parameters with a similar methodology, they suggested a geothermal electricity price. However, those three research studies exercised and simulated geothermal generation costs in Indonesia without considering any government guarantee, so they did not calculate any relevant fiscal cost to the Indonesian government.

2.5 Past Models and Variables

Yusuf et al. (2010) used a CGE model named AGEFIS-E (Applied General Equilibrium model for FIScal Policy Analysis – Energy) based on the Social Accounting Matrix (2005). The model consists of a production structure of 33 sectors, a nested Leontief production function intermediating inputs and value-added, which allows for substitution of energy. Based on the Armington specification, the option of domestic and import consumption was optimised. Households received income from their possession of the production factor and transfers from other institutions, then the income was maximised with a Cobb-Douglas utility function under a budget constraint. Government revenue was from indirect taxes, direct taxes, the ownership of factors, and transfers and government expenditure were for consumption, commodity subsidies, and transfers.

In investigating renewable energy company risk, Sadorsky (2012) uses three beta models. The first model is:

$$R_{it} = \alpha_{it} + \beta_{it} R_{mt} + \varepsilon_{it} \tag{2.1}$$

R_{it} symbolises the renewable company's stock returns, i denotes the company, t denotes the time period. Variable α_{it} is the component of a security's returns that are independent of the market while β_{it} is market beta and R_{mt} reflects the overall stock market returns. The company stock return is also affected by random error (ε_{it}) which is assumed to be distributed with a zero mean and constant variance in this model.

Meanwhile, he argues that for renewable energy companies the systematic risk varies and depend on several factors:

$$\beta_{it} = \delta_i + \gamma_{1i} size_{it} + \gamma_{2i} dtoe_{it} + \gamma_{3i} rdsales_{it} + \gamma_{4i} salesg_{it} + \gamma_{5i} oilreturn_t + V_{it} \tag{2.2}$$

He determines that systematic risk depends on time, size of the firm (size), the debt to equity ratio (dtoe), the research and development expenditure to sales ratio (rdsales), sales growth (salesg), and oil price returns (oilreturn).

Equation (2.1) is combined with equation (2.2) to create Model 2:

$$R_{it} = \alpha_i + \delta_{1i} R_{mt} + \gamma_{1i} size_{it} R_{mt} + \gamma_{2i} dtoe_{it} R_{mt} + \gamma_{3i} rdsales_{it} R_{mt} + \gamma_{4i} sales_{it} R_{mt} + \gamma_{5i} sales_{it} R_{mt} + \varepsilon_{it} \tag{2.3}$$

Theoretically, an increase in company size or in sales growth reduces systematic risk so an increase in the debt to equity ratio, research and development to sales ratio, or oil price returns increases systematic risk.

Model 2 is then restricted to reject any statistically insignificant coefficients by applying a Chi-Squared test to make Model 3. It was found that the insignificant variables are the size of the company, debt to equity, and research and development. Meanwhile, the significant variables were sales growth, and oil price returns. Furthermore, the impact of those significant variables on the company beta value was investigated with a Monte Carlo simulation based on an estimated coefficient from Model 3 as follows:

$$\beta = 2.0714 - 0.0087\ salesg + 0.0874\ oilreturn \tag{2.4}$$

A Monte Carlo simulation was also conducted by Sun and Zhang (2015) to simulate NPV with stochastic variables. To find the optimum minimum revenue guarantee (MRG) and royalty rate in a BOT wastewater PPP project in China, they calculated with a revised NPV evaluation model. The project would be continued if the project NPV had a minimum value of 0. NPV can be calculated as follows in equation (2.5).

$$NPV = \sum_{t=T_b+1}^{T_c} \frac{(P_t - C_t) x Q_t}{(1+r)^t} - \sum_{t=0}^{T_b} \frac{I_t}{(1+r)^t} \tag{2.5}$$

Variable Pt defines concession price per unit in year t while C_t is the operation and maintenance costs in year t. Volume or quantity of the service provided by the project annually is denoted by Q_t. Variable I_t reflects construction cost in year t, r denotes the basic discount rate (weighted average cost of capital of project or discount rate within a similar industry), T_c is the concession period, and T_b is the construction period. If MRG and royalty are considered, the NPV formula is modified to become $NPV_{G\&R}$ in Equation (2.6).

$$NPV_{G\&R} = \sum_{t=T_b+1}^{T_c} \frac{\max[R_G, P_t\ x\ Q_t\ x\ (1-\theta)] - C_t x Q_t}{(1+r)^t} - \sum_{t=0}^{T_b} \frac{I_t}{(1+r)^t} \tag{2.6}$$

T_c is the concession period, minimum revenue is $R_{G,}$ and P_t x Q_t denotes the operating revenue of the private company. As the researchers assume the royalty based on the revenue, so royalty is symbolled by θ.

In this research, there were three uncertain parameters, not deterministic: P_t (normally distributed), C_t (uniformly distributed), and Q_t (normally distributed) so, they needed to run a Monte Carlo simulation to do the calculation with the help of Crystal Ball software. Afterwards, the optimum minimum guarantee was calculated by minimising Z, a difference between $NPV_{G\&R}$ and NPV_{exp} (the expected NPV):

$$MinZ = NPV_{G\&R} - NPV_{exp} \tag{2.7}$$

Subject to

$$Z \geq 0 \tag{2.8}$$

$$0 \leq R_G \leq R_0 \tag{2.9}$$

$$0 \leq \theta \leq 100\% \tag{2.10}$$

$$T = 0,1,2,\ldots, T_c$$

Regarding minimum revenue guarantee and debt guarantee, the International Monetary Fund and World Bank Group (2016) provide a free tool to assess contingent liabilities from those guarantees. It is named PFRAM, a Microsoft Excel tool with a macro based model so users can input project data and macro data then PFRAM will calculate the fiscal risk. However, this model is deterministic and without any detailed explanation about how it works to calculate the input into several outputs including fiscal risk

Fiscal risks from government guarantees in Indonesia were modelled by Wibowo et al. (2012) for the case of toll roads. Some government guarantees available for toll road investors are land-capping, no delay in toll adjustment, and no nationalisation. Basically, land capping guarantees that investors only have to pay 110% of the agreed land cost in a concession agreement or 100% of the cost plus 2% of the total toll road investment whichever is greater.

$$C_L^u = \begin{cases} 1.10C_L^b & if\ \frac{C_L^b}{C_L^b + C_{nL}^b} \geq 0.20 \\ 1.02_L^b + 0.02C_{nL}^b & if\ \frac{C_L^b}{C_L^b + C_{nL}^b} < 0.20 \end{cases} \tag{2.11}$$

C_L^u is the assumed maximum cost by investors, C_L^b is base land cost, and C_{nL}^b is investment cost without land cost. If the land cost is more than the guaranteed price, the government will pay the difference so that the project internal rate of return (IRR) is a minimum 12%. So, this 12% of IRR is the threshold for the government to pay the guarantee. If Δ is the threshold then it can be calculated as follows:

$$\Delta = \sum_{t=0}^{d_n} \frac{CF_t^b}{[1+\max(IRR_{min}, IRR_b - \alpha)]^t} \quad (2.12)$$

Variable CF_t^b is base cash flow in year t, minimum IRR after land cost escalation is denoted by IRR_{min} and α is the maximum reduction in IRR because of escalation of land cost. Contingent liabilities for land capping guarantee ($\widetilde{GL}$) depend on the actual land cost ($\tilde{L}$) and can be formulised as:

$$\widetilde{GL} = \begin{cases} 0 & if \tilde{L} \leq C_L^u \\ \min(\Delta, \tilde{L}) - C_L^u & if \tilde{L} > C_L^u \end{cases} \quad (2.13)$$

The government guarantees that tolls will be adjusted every two years. If the government fails to do so, the government has to compensate the investor a certain amount:

$$\widetilde{GP} = \begin{cases} 0 & if\ \tilde{P}_t = \tilde{P}_t^b \\ (\tilde{P}_t^b - \tilde{P}_t)\tilde{V}_t & if\ \tilde{P}_t < \tilde{P}_t^b \end{cases}$$

For t = $d_c + 1$, $d_c + 1$, …,d_G, $d_G \leq d_N$ (2.14)

Where $\widetilde{GP}$ is government compensation for toll delay, $\tilde{P}_t$is the contractual toll at year t, $\tilde{P}_t^b$ is the future contractual toll, $\tilde{V}_t$ is traffic in year t, and d_G is duration of the nationalisation guarantee. The nationalisation guarantee is calculated with a Monte Carlo simulation with the Crystal Ball software package under the following formula:

$$\widetilde{PGN} = \sum_{t=0}^{d_G} \frac{\delta_t \widetilde{CF}_t}{\prod_{i=0}^{t}(1+\tilde{r})}, d_G \leq d_N \quad (2.15)$$

and

$$\delta_t = \begin{cases} 0 & if\ t \leq t_x \\ 1 & ifif\ t > t_x \end{cases} \quad (2.26)$$

$\widetilde{PGN}$ denotes the payment of a nationalisation government guarantee while t_x is the year of nationalisation. As in Indonesia land capping and toll adjustment are only for toll roads, this model is only applicable for the toll road sector.

For the geothermal sector, the Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) provide a detailed financial model. The inputs of the model consist of field assumptions, field activities, schedule, finance arrangements, incentives, CDM, and other parameters. Each of the inputs is connected to more complicated financial calculations. For example, for ‘Output of Power Plant’, one input in field assumptions, among other things, is connected to the project cost, including steam field and power plant development, and makeup well cost. Each of these costs is also segregated in more detail costs. Meanwhile, the primary output data consist of project cost, IRR, WACC, and energy sales price. Similar to the inputs, the output data are derived from data from many financial equations. However, this model does not account for any government guarantee in the incentive calculation.

Later, Castle Rock Consulting (2010) updated the geothermal technical data by verifying most geothermal sites in Indonesia. The Asian Development Bank and The World Bank (2015) then updated the Castle Rock data.

2.6 Chapter Summary

A PPP scheme delivers benefit to both the government and the people. In line with the Indonesian needs to build more geothermal power plants, the government provides guarantees to reduce the investment risk, including Business Viability Guarantee and Debt Guarantee policies. These guarantees can result in fiscal risk. There are several past studies related to PPPs, fiscal policies for infrastructure projects, renewable energy, and particularly geothermal projects, but research on fiscal risk from a guarantee policy has not been found. However, there is some research that implements a quantitative approach with a Monte Carlo simulation to quantify uncertain (probabilistic) parameters such as risk. There is also a study which estimates fiscal risk from contingent liabilities for toll road projects in Indonesia but for another type of government guarantee. Therefore, this study is filling a gap in the literature regarding fiscal risk assessment for geothermal projects in Indonesia. In the following chapter, the research framework used to answer the research questions of this study will be presented.

Chapter 3
Research Framework

3.1 Introduction

Chapter 2 examined past studies related to PPPs, fiscal risk and geothermal development along with several models and variables. However, it was found that there is no study yet about fiscal risk from government guarantees for geothermal projects in Indonesia. Therefore, in this chapter the research framework for assessing fiscal risk from government guarantees for geothermal projects will be presented. This chapter presents the research framework of the study used to answer the research questions. A general logical framework to identify fiscal risk is presented, including how to assess its probability and impact. In the end section, a method to minimise the risk is explained.

3.2 Research Framework

This study applies a quantitative method which simulates certain variables to answer the research questions stated in Chapter 1: simulation modelling is conducted, particularly to identify fiscal risk including its probability and impact from the government guarantees for geothermal projects.

3.2.1 Quantifying Fiscal Risk in Government Expenditure Due to Government Support Programs for Renewable Energy Projects

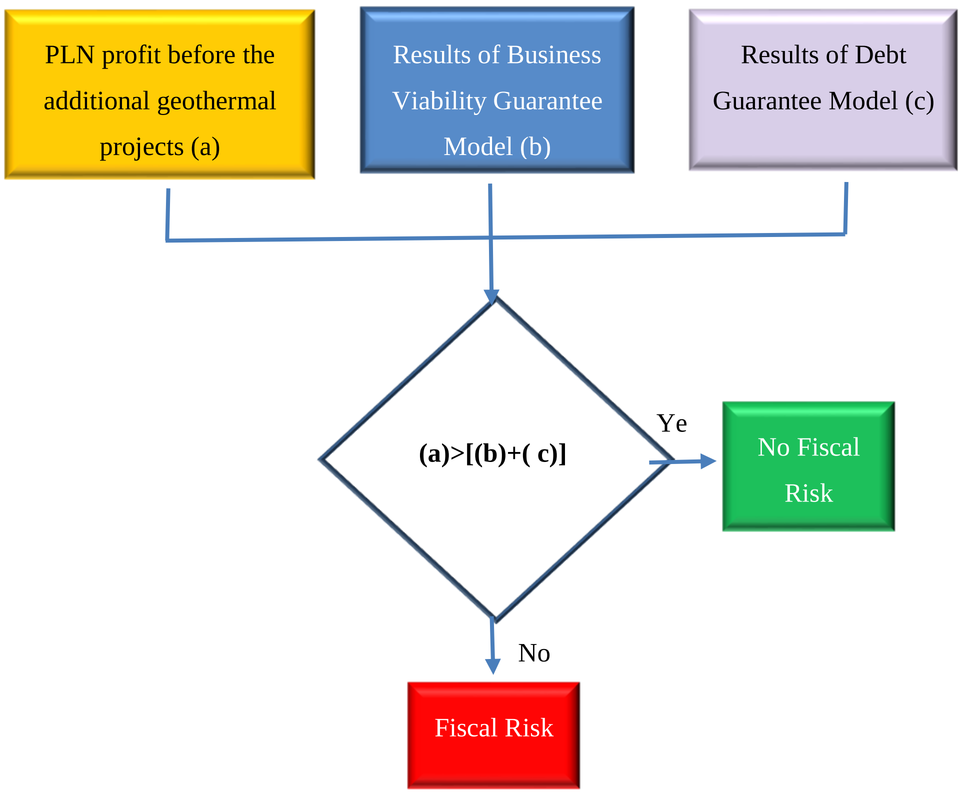
Risk identification is the first step in the risk management process. It is a critical step in the risk management process to ensure the effectiveness of risk management (Pritchard 2014). Risk identification comprises a "process of finding, recognising and describing risks which involve the identification of risk sources, events, their causes and their potential consequences" (International Organization for Standardization 2009, p. 4). It identifies what, where, when, why and how risks could arise, and the effect on the achievement of the objectives (Victorian Department of Treasury and Finance 2015). There are many approaches to identifying risks to which an organisation could be exposed. These include risk checklists, root cause analysis, benchmarking (Grimsey &

Lewis 2005) and creating a Monte Carlo simulation model (Wibowo et al. 2012; Wibowo & Wilhelm Alfen 2014).

This study quantifies fiscal risk related to Business Viability Guarantees and Debt Guarantees for renewable energy projects in Indonesia which focus on geothermal projects which are planned to start from 2018, and 2019. This risk arises when PLN is unable to meet its obligations; the obligation to IPPs for purchasing their electricity and debt obligations to lenders. As currently PLN has several geothermal projects, any new development of geothermal projects is considered as an additional geothermal project. The assessment of PLN's ability to meet its obligations is conducted by comparing its profit before the additional geothermal projects and net deficits from the additional projects.

This study constructed three models to identify and assess the fiscal risk: first, a model to calculate PLN profit before the additional geothermal projects. Second, a Business Viability Guarantee Model to investigate the financial impact for PLN as a result of purchasing electricity from IPPs which can either add surplus or deficit to PLN. Third, a Debt Guarantee model which simulates PLN geothermal projects' financial conditions, whether they are in surplus or deficit. There might be a fiscal risk if the PLN's profit for a particular year is less than the net deficit resulting from the Business Viability Guarantee and Debt Guarantee models (see Figure 3.1).

Figure 3.1 Modelling Framework



To allocate the guarantee payment, the fiscal risks from the Debt Guarantee and Business Viability guarantee need to be assessed with the help of a Monte Carlo based financial model. The government pays the government guarantee if PLN cannot fulfil its financial commitment to IPPs (for Business Viability Guarantees) and creditors (for Debt Guarantees) related to the geothermal projects. Meanwhile, PLN (as a corporation) will pay these commitments if, at the project level, the projects' revenue is less than their projects' obligations (purchased electricity payment and debt service). The government will pay the guarantee if in any particular year, PLN's financial condition, before incorporating the geothermal projects, does not allow PLN to meet its financial obligations from purchasing electricity from IPPs and debt commitments. Therefore, the PLN financial condition needs to be simulated to calculate both of the government guarantees.

The government basically guarantees PLN's ability to pay IPPs and lenders. As it is related to the power plant projects, there is no Business Viability Guarantee exposure if each IPP can make a surplus, a condition that occurs when the electricity purchased from an IPP can be retailed for more than its cost. There is no Debt Guarantee if each of geothermal power plants can make earning before debt service equal to or more than its debt service obligation for a year. If PLN can only make surplus and profit from some of the projects, the sum of the surpluses and deficits need to be compared to PLN's overall operating profit before the additional electricity supply from IPPs and power plants. If the overall profit is equal to or more than the net deficits, PLN can fulfil its own obligation without help from the government.

$$GG_t = PLNP_t + \sum_1^n IS/D_t + \sum_1^n PS/D_t \tag{3.1}$$

In this equation, GG_t denotes government guarantee for year t, $PLNP_t$ reflects PLN corporate profit excluding electricity from the IPPs' geothermal projects in year t, and IS/D_t means surplus/(deficit) of the IPPs' geothermal projects (sales revenue minus its purchasing cost in year t). Meanwhile, PS/D_t expresses surplus/(deficit) of PLN's geothermal power plants (power plants' profit minus debt payment in year t). If PLN's power plants suffer a deficit, PLN needs to take over all the debt obligation.

Geothermal law regulates that the geothermal power plant should be built a maximum of 5 years from the bidding date and can be extended twice, for one year each time (President of the Republic of Indonesia 2014a). Meanwhile, the Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) assumed a four year geothermal power plant development. Therefore, in this study, it is assumed that power plant development requires 5 years. Geothermal power plant projects which will commercially operate in 2018 are the projects which have been developed from 2013: the Sarulla and Lahendong VI projects. All of them are IPP projects. Furthermore, the IPP projects which began development from 2014 are Lumut Balai, Tulehu, Patuha, Tangkuban Perahu 1, and Dieng. In the same year, PLN started building the Ulumbu, Mataloko, and Atadei geothermal power plants. Therefore, for 2018 and 2019 it can be formulated as follows:

$$GG_{2018} = PLNP_{2018} + IS/D_{Sarulla\ 2018} + +IS/D_{Lahendong\ VI\ 2018} \tag{3.2}$$

$$GG_{2019} = PLNP_t + IS/D_{Sarulla\ 2019} + +IS/D_{Lahendong\ VI\ 2019} + IS/D_{Lumut\ Balai\ 2019} + IS/D_{Tulehu\ VI\ 2019} + IS/D_{Patuha\ 2019} + IS/D_{Tangkubang\ Perahu\ I\ 2019} + IS/D_{Dieng\ 2019} + PS/D_{Ulumbu\ 2019} + PS/D_{Mataloko\ 2019} + PS/D_{Atadei\ 2019} \tag{3.3}$$

3.2.2 Probability and consequences associated fiscal risks

The International Organization for Standardization (2009) and Standards Australia/Standards New Zealand (2009) define risk as an "effect of uncertainty on objectives". An effect is a difference from expectation, negative and/or positive. Risk consists of probability and consequences (impact), so in assessing fiscal risk from government guarantees, the likelihood and fiscal risk impact need to be measured. Aven (2011) argues that likelihood in term of risk is the same as the probability

3.2.2.1 Probability

The International Monetary Fund and World Bank Group (2016) categorise probability of fiscal risk into three levels: low, medium, and high. As a probability is between 0-100%, if it is divided into three levels, it then can be inferred that a low level of probability is a probability between 0-33.33%, medium 34-67%, and high 68-100% (see Table 3.1).

Table 3.1 Scale of fiscal risk probability

Scale	Likelihood
Low (Up to 33% probability)	• Very unlikely but not negligible • Would require highly unusual circumstances • There are effective mitigation measures in place
Medium (Between 33.3% - 66.7% probability)	• Likely, and possible • Not unprecedented • There are mitigation measures in place, but they are not effective and/or are not applied consistently
High (Above 66.7% probability)	• Very likely, almost certain • Extensive precedents • No mitigation measures in place to prevent them

Source: International Monetary Fund and World Bank Group (2016, p. 21); Kwak and Ingall (2007); Rezaie et al. (2007).

3.2.2.2 Consequence (Impact)

The International Monetary Fund and World Bank Group (2016) segregates fiscal impacts into three levels depending on its proportion of Gross Domestic Products (GDP). It is low risk when the fiscal impact is no more than 0.5% of GDP; it is moderate if the fiscal impact is between 0.5%-1.0% of GDP and it is high if the fiscal impact is more than 1% of the GDP (see Table 3.2). In this study, the results will be presented both in probability distribution and mean value. The mean value is the result of multiplication of each probability with its impact so it will reflect fiscal risk level.

Table 3.2 Fiscal risk impacts

Scale	Fiscal Impacts
Low (Up to 0.5 % of GDP)	• Impact on government deficit and debt is lower than 0.5% of GDP • Minimal damage to government's reputation, service reputation, service availability, and operation
Moderate (Between 0.5%-1.0% of GDP)	• Impact on government deficit and debt between 0.5%-1.0% of GDP • Limited damage to government's reputation, service reputation, service availability, and operation
High (Above 1.0% of GDP)	• Impact on government deficit and debt more than 1.0% of GDP • Significant damage to government's reputation, service reputation, service availability, and operation

Source: International Monetary Fund and World Bank Group (2016, p. 21).

According to the International Monetary Fund (2016), Indonesia will have a GDP of IDR 15,128 trillion for 2018 and for the following year it will increase to IDR 16,693 trillion. Therefore, the fiscal risks will be low if the exposure is under IDR 75.6 trillion, medium if it lies between IDR 75.6 trillion to IDR 151 trillion, and it will be high if it is more than IDR 151 trillion for 2018 (see Table 3.3).

Table 3.3 Fiscal impact threshold for 2018 and 2019 in IDR million

	Projected GDP in the current price	**Fiscal impact thresholds**	
		0.5% of GDP	**1% of GDP**
2018	15,127,885,438	75,639,427	151,278,854
2019	16,692,954,557	83,464,773	166,929,546

Source: Author's calculation.

In terms of fiscal impacts for the government guarantee, the impacts are in the form of a cash guarantee payment, so the government needs to ensure that at the time of the guarantee payment, there is sufficient cash available to make the payment. The historical data shows that for the past 8 years, the Indonesian government has always had a cash balance more than IDR 80 trillion (see Figure 3.2).

Figure 3.2 Cash balance of the Indonesian government for the period of 2009-2016 in IDR million

Source: Menteri Keuangan Indonesia (2009, 2011a, 2013, 2015a, 2017a).

Spending for a cash balance to finance government spending is allocated in the Indonesian national budget. Regarding fiscal risk management, the budget also consists of chapters of fiscal risk statements outlining potential sources of fiscal risk, including risk from macroeconomic assumptions, government revenue, government expenditure, government financing, contingent liabilities, natural disaster, food price stabilisation, lawsuits directed at the government, government home loans for low income people, and risks from renewable energy development. The chapters also detail fiscal risk impact assessments from each of fiscal risk source and risk mitigation plans, including allocation of a certain amount of expenditure as a buffer for several guarantees if they really happen (see Table 3.4).

Table 3.4 Guarantee allocation in the Indonesian National Budget in IDR billion

No	Government guarantees program	2013	2014	2015	2016	2017	2018
1.	***The 1st fast track 10,000 MW electricity program***	611	914	792	570	450	**297**
2.	***Clean water supply projects***	35	2	2	1	1	**1**
3.	***Direct lending projects***	-	-	-	-	21	**-**
4.	***Trans Sumatera tolled road projects***	-	-	-	-	40	**285**
5.	***The 2nd fast track 10,000 MW electricity program***	-	-	-	-	-	**-**
6.	***PPP projects***	60	48	50	81	201	**390**
7.	***Projects assigned to State Owned Enterprises (SOEs) to finance infrastructures in municipalities***	-	-	-	-	203	**-**

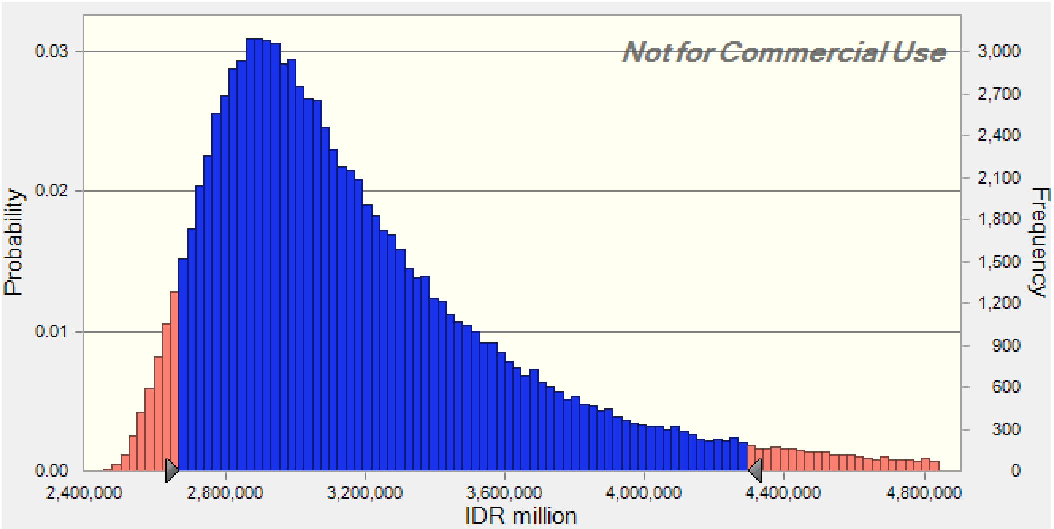
Source: Republik Indonesia (2017).

For the past six years, the Indonesian government has identified seven government guarantees which might lead to fiscal risks, including the government guarantee for the first track 10,000 MW coal power plant program, clean water supply projects, direct lending projects (project loans from an international financial institution), the trans Sumatera tolled road project, the second fast track 10,000 MW program, PPP projects other than for power plants, and projects assigned to State Owned Enterprises (SOEs). A Business Viability Guarantee and Debt Guarantee are included in the guarantees for the second fast track 10,000 MW program. Apparently in past years, the government has identified fiscal risk from the second 10,000 MW program, but the guarantee payment has not been budgeted for yet.

3.2.2.3 Level of Fiscal Risk

After calculating the fiscal risk impacts and probabilities for a Business Viability Guarantee and Debt Guarantee, the level of fiscal risk can be assessed. This study applies a Monte Carlo simulation with the help of Crystal Ball software, which presents results both in probabilistic distributions and deterministic number. The probabilistic results are presented in histograms, for example, Figure 3.3 which shows X-axis of consequences and Y-axis of probabilities. It displays probabilities for each of 50 bins of consequences (impacts). There are slight probabilities (just over zero percent), in left and right tails of the histogram, that the risk impact will be under IDR 2,400,000 million or more than IDR 4,500,000. As the tails present extreme values, very small or huge impacts but with very small probabilities, this study also demonstrates the results under 90% certainty level. Under this certainty level, in the example of Figure 3.3, the possible impact is between IDR 2.7 to 4.3 trillion for 2018.

Figure 3.3 Example 1, an example of a probability distribution graph



Monte Carlo analysis generates random numbers which might be different for each simulation run (iteration) following each probability distribution to predict every independent variable in the model. The first trial of the simulation results in one probability and one impact, the second trial will also result in one different probability and impact. Therefore, to create outputs in the form of a histogram, the simulation needs to be run many times. As a Monte Carlo model is re-run, it might result in different outputs from the previous trial so trials should be conducted to an optimal number of trials so that when the simulation is re-run, the result has a very slight variation with the previous run. More trials produce a more precise simulation result, so this study simulated with 100,000 trials, the maximum number of trials that could be conducted with the author's computers, but this simulation was conducted with precision control of 95% confidence level.

Meanwhile, this study also presents a deterministic value in a summary of descriptive statistics presenting several parameters including a number of trials, the centre of measurement (mean and median), standard deviation, skewness, minimum and maximum numbers (see Table 3.5 for an example). A median value 3,079,889 means that there is

50% probability that the impact will be more than 3,079,889. Furthermore, these parameters also help to understand the histogram. In the example, the mean value of 3,232,571 is known from the descriptive statistics (Table 3.5) but the probability to get this number is reflected in the histogram (Figure 3.3) around the frequency number of 1,900 out of 100,000. Therefore, the probability of getting an impact of 3,232,571 is around 1.9%.

Table 3.5 Descriptive statistics of Example 1

Statistics	Forecast values
Trials	100,000
Base Case	3,074,762
Mean	3,232,571
Median	3,079,889
Standard Deviation	574,605
Skewness	3.01
Kurtosis	25.02
Coefficient of Variation	0.1778
Minimum	2,453,653
Maximum	20,166,920
Mean Std. Error	1,817

3.2.3 Minimising Fiscal Risk

As a fiscal risk consists of fiscal impact and risk probability, minimising risk can be conducted by either minimising risk, minimising probability, or a combination of both. To identify the contributing factor in fiscal risk, sensitivity analysis will be conducted. This study will use Tornado Analysis to find the most sensitive variable in the model. After the variables are found, it will be analysed to find out the possibility of decreasing the probability or the impact. This effort might need cooperation between the government and the private sector to share, transfer, or retain the risk.

3.3 Chapter Summary

This chapter has provided the research framework in doing this research. It described ways of quantifying fiscal risk and assessing level of fiscal risk, including how to measure fiscal risk probability and consequence. A method to minimise fiscal risk was also explained. Fiscal impact measurement (low, medium, high) was also described and compared with Indonesian GDP so that when fiscal risk impact is known, it can be measured and categorised to prepare a mitigation plan. Furthermore, in assessing the fiscal from Business Viability Guarantees and Debt Guarantees, this study constructs three simulation models. The first model, the PLN simulation model, will be explained in the following chapter.

Chapter 4
PLN Simulation Model

4.1 Introduction

Chapter 3 presented the research framework to this study, including the simulation model framework which consists of the PLN simulation model, the Business Viability simulation model and the Debt Guarantee simulation. This chapter will elaborate the first model, the PLN simulation model, which incorporates a simulation of PLN's income statement before incorporating income from electricity from current geothermal projects and any additional geothermal project either developed by IPPs or PLN, for 2018 and 2019. A detailed model for revenue, including how to estimate sale of electricity, connection fee, and other revenue, will be explained. Operating costs and non-operating income/(loss), as well as a subsidy from the government, will be calculated. In the end, the simulation results will be disclosed.

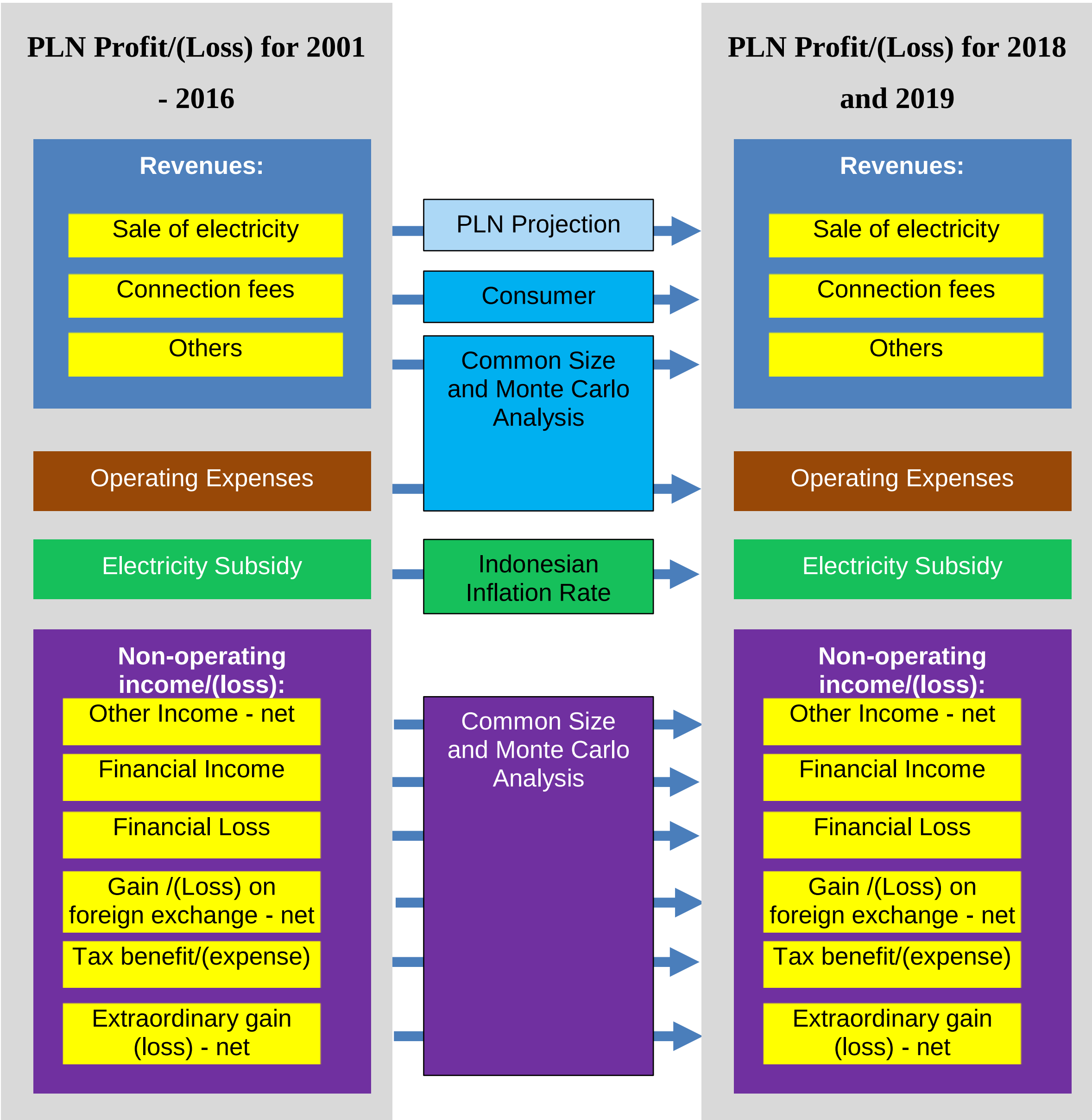
4.2 Model Framework

Perusahaan Listrik Negara (PLN), which literally means national electricity company, is the only Indonesian state-owned enterprise (SOE) in the power sector. Its business includes generation, transmission, distribution, and retail of electricity. PLN owns power plants and acts as the sole purchaser of any electricity produced by Independent Power Producers (IPPs). It controls and operates all electricity transmission and distribution in Indonesia and serves more than 60 million consumers in Indonesia (PT Perusahaan Listrik Negara (Persero) (2016c). For 2016, its total assets were worth around IDR 1,275 trillion or around AUD 127 billion, and it had approximately IDR 11 trillion or approximately AUD 1 billion net income (PT Perusahaan Listrik Negara (Persero) 2017).

This study forecast PLN financial conditions for the years 2018 and 2019 based on its historical financial performance. Although PLN has been operating in Indonesia since 1945, the available financial data for forecasting is financial data from 2001 – 2016. The main reason is that at the end of the 1990s, Indonesia suffered from a crisis, including a monetary crisis that appreciated USD value to more than six times. Therefore, PLN's Income Statements from 2001to 2016 are used to forecast the PLN Income Statement for

2018 and 2019. The Income Statement consists of revenue, operating expenses, electricity subsidy, and non-operating income/(loss). PLN has made its sales projection from its customer numbers until 2025, so in calculating the sale of electricity and connection fees for 2018 and 2019, PLN's projection numbers are used. Furthermore, the electricity subsidy is predicted based on its historical value and adjusted with the Indonesian inflation rate. Meanwhile, common size and Monte Carlo analysis are conducted to estimate other income (revenue section), operating expenses, and non-operating income/(loss) (Charnes 2007), as shown in Figure 4.1.

Figure 4.1 Model framework of PLN profit/(loss)



The primary revenue of PLN is from the sale of electricity, and the main expenditure is for operating expenses, primarily for fuel and lubricant. The second largest income for PLN is from government subsidy followed by customer connection fees and other income. Since 2014, PLN has also received other comprehensive income. For 2015, in this comprehensive income, PLN gained most from an asset revaluation reserve, but for 2016, PLN made a loss because of actuarial loss (see Table 4.1).

Table 4.1 PLN Consolidated statements of profit or loss and other comprehensive income for the years ended December 31, 2016, and 2015, in IDR million

	2016	**2015**
Revenue		
Sale of electricity	214,139,834	209,844,541
Customer connection fees	7,052,136	6,141,335
Others	1,629,986.00	1,361,114
Total revenue	222,821,956	217,346,990
Operating expenses		
Fuel and lubricants	109,492,383	138,408,315
Purchased electricity	59,729,390	4,420,859
Lease	6,545,114	8,065,522
Maintenance	21,226,736	21,861,310
Personnel (wages, salaries, benefits)	22,659,965	20,321,137
Depreciation	27,512,150	25,406,856
Other	7,284,064	7,090,077
Total operating expenses	254,449,802	225,574,076
Operating loss before subsidy	**(3,314,640)**	**(8,227,086)**
Government's electricity subsidy	60,441,520	56,552,532
Operating income after subsidy	**28,813,674**	**48,325,446**
Non-operating income		
Other income - net	1,092,366	2,437,066
Financial income	578,507	627,412
Financial cost	(18,703,276)	(39,977,228)
Gain /(Loss) on foreign exchange - net	4,195,210	(27,326,131)
Income /(Loss) before tax	**15,976,481**	**(15,913,435)**
Tax benefit/(expense)	**(5,427,843)**	**21,939,942**
Income for the year	**10,548,638**	**6,026,507**
Other comprehensive income for the year	**10,548,638**	**6,026,507**
Items that will be subsequently reclassified to profit or loss:		
Share of other comprehensive income of associated and joint ventures	-9,313	36,978
Items that will not be subsequently reclassified to profit or loss:		
Actuarial gain/(loss)	(2,766,341)	6,120,608
Asset revaluation reserve	2,287	653,441,219
Related income tax (expense) benefits	691,585	(16,865,984)
Total other comprehensive income/(expense) for the year	**8,466,856**	**648,759,328**

Source: PT Perusahaan Listrik Negara (Persero) (2017, p. 582).

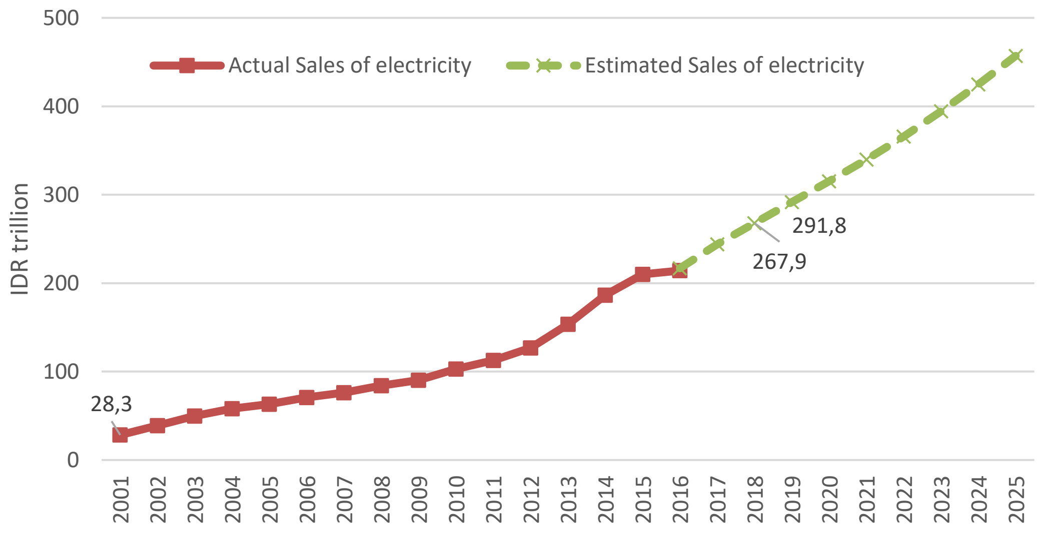
4.3 Simulation Model

PLN's main business is retailing electricity, so its main revenue is from the sale of revenue. However, the Sale of Electricity figure in PLN's financial statement does not reflect a fair amount since PLN also sells the electricity at a subsidised price. Therefore, the fair amount needs to be calculated as Sale of Electricity plus electricity subsidy for a particular year. After the Sale of Electricity and Electricity Subsidy figures are known, using the common size method, other income statement figures can be estimated.

4.3.1 Sale of Electricity

The Indonesian Ministry of Energy and Mineral Resources and PLN have made a projection of PLN sales projections until 2025. It is estimated that the PLN sale of electricity for 2018 and 2019 will be around IDR 268 trillion and IDR 292 trillion consecutively (see Figure 4.2). This number will be almost ten times the sale for 2001 as the government and PLN accelerate the development of power plants in Indonesia.

Figure 4.2 PLN Sales of Electricity, actual and projection, for 2001-2025



Source: PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

PLN is the sole electricity retailer and distributor in Indonesia, so when the electrification ratio is under 100%, the volume of electricity sold is practically similar to the total electricity demand in Indonesia. PLN sales are a function of electricity sold to customers and electricity price. The electricity price is regulated and set periodically (usually every one or three months). On average, the sales average grew by just under 15% annually with a range of 36% and a standard deviation of about 9% (see Table 4.2).

Table 4.2 Descriptive statistics of PLN sales growth for the period of 2001-2016 in IDR million

Observations	*15*
Mean	*14.77%*
Median	*12.30%*
Minimum	*2.05%*
Maximum	*37.99%*
Std. Deviation	*9.14%*
Skewness	*1.28*

Source: PT Perusahaan Listrik Negara (Persero) (2011, 2012, 2013, 2014a, 2014b, 2015, 2016b) and PLN's annual reports 2001-2009.

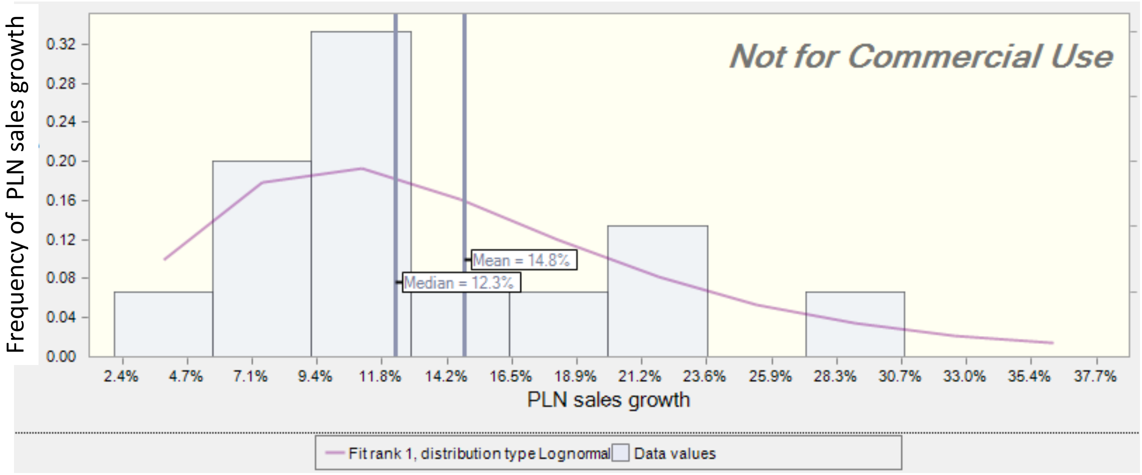
For the last 15 years, PLN had been selling on average more than IDR100 trillion or AUD 100,000 million of electricity with a positive trend which increases the national electrification ratio. However, its sales growth decreased sharply from 2002-2005 though it rebounded sharply from 2011 to 2013 before falling again. PLN has predicted that in 2017, it will grow to just under 15% then grow steadily until 2025 (see Figure 4.3).

Figure 4.3 PLN sales growth, 2001-2025.

Source: PT Perusahaan Listrik Negara (Persero) (2011, 2012, 2013, 2014a, 2014b, 2015, 2016b, 2016d, 2017) and PLN's annual report 2001-2009.

The distribution of PLN sales growth is left skewed with most of the data below the median value (see Figure 4.4). The data series was found to follow a lognormal distribution with a mean of 14.9% and a standard deviation of 9.3%.

Figure 4.4 Histogram of PLN sales growth, in IDR trillion



Source: Author's calculation from PLN Annual Reports 2001-2016.

4.3.2 Electricity Subsidy

The government has been subsidising electricity for some types of customers. The electricity customers in Indonesia are divided into several groups (Menteri Energi dan Sumber Daya Mineral Indonesia 2016) as follows:

a. Social,
b. Household,
c. Business,
d. Industry, and
e. Government.

In the first decade of the century, all customer groups received electricity subsidies costing the Government of Indonesia on average more than IDR 50 trillion. This figure fluctuated widely every year with a range of around IDR 100 trillion and a standard deviation of more than IDR 37 trillion (see Table 4.3).

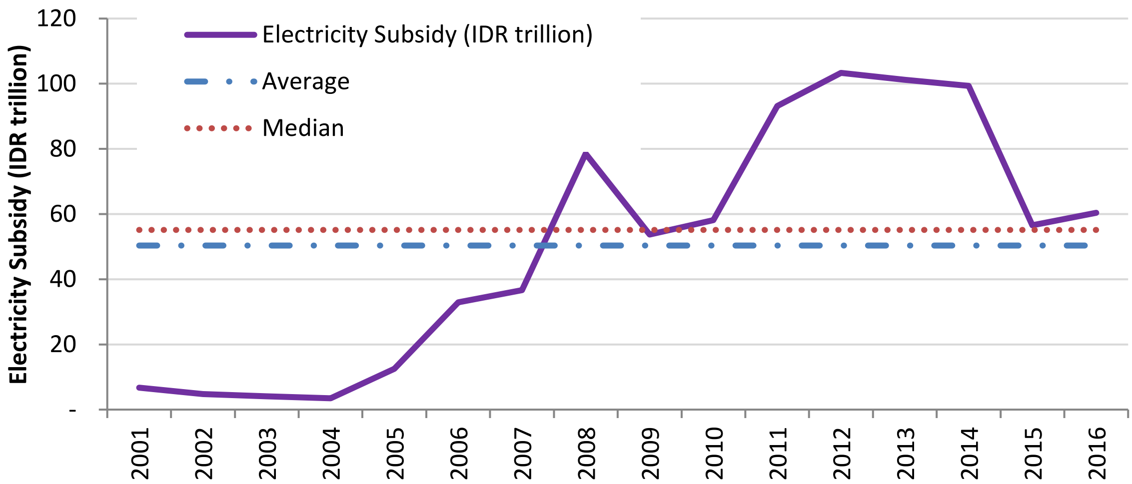
Table 4.3 Descriptive statistics of electricity subsidies for the period of 2001 – 2016 in IDR Million

Observations	16
Mean	50,342,844
Median	55,136,175
Minimum	3,469,920
Maximum	103,331,285
Std. Deviation	37,307,237
Skewness	0.09

Source: PLN annual reports 2001-2016.

The current policy of the Government is to direct the subsidy to the low-income population. Since 2011, the subsidy has fluctuated between IDR 3.5 trillion in 2004 and more than IDR 100 trillion in 2012. During the oil price boom during the period 2007 – 2012 (Center for Data and Information Technology 2016), the electricity subsidy also increased sharply. However, this steadily decreased from 2015 onward with the newly elected government implementing policies to reduce subsidies on electricity (see Figure 4.5).

Figure 4.5 Government electricity subsidy, 2011-2016, in IDR million.

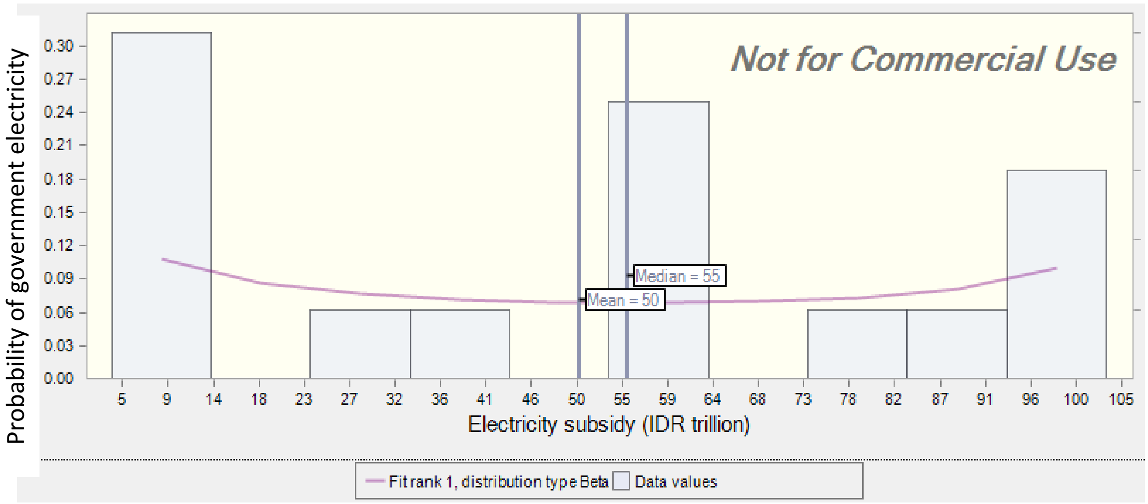


Source: PLN annual reports 2001-2015; APBN 2016, 2017.

The Indonesian Government, however, continue to provide a subsidy to PLN so that it can recover its financing needs (Menteri Keuangan Indonesia 2015b). This subsidy follows equation 3.4’s formula which indicates that level of subsidy is related to the cost of generation. As PLN’s fuel mix was mostly from fossil fuel, its generation costs increased along with increasing fossil fuel prices. During 2011-2014, when oil and coal reached their peak prices, the subsidies reached their peak as well (see Figure 4.5). The highest oil price in that particular period was in 2012 at USD 115.59 per barrel (Center for Data and Information Technology 2015, p. 30), which corresponded with the highest electricity subsidy.

Global fossil fuel prices fluctuated with rapid jumps and falls on the fuel price, which was then transmitted to the electricity subsidy, concentrated near the minimum and maximum values. Therefore, the electricity subsidy series data are almost not skewed, having nearly zero skewness value (see Figure 4.6). However, the picture of the subsidy may be changing for upcoming years, as the government has committed to giving greater priority' to poor people (Menteri Energi dan Sumber Daya Mineral Indonesia 2016).

Figure 4.6 Histogram of government electricity subsidy, in IDR trillion



Source: PLN annual reports 2001-2015; APBN 2016, 2017.

4.3.2.1 Subsidy Formula

PLN sell electricity to its customers based on a regulated price which might be lower than its cost, so the government pays the electricity subsidy to fill the difference (Menteri Keuangan Indonesia 2017b). It is calculated as follows:

$$S = -(TTL – BPP\ (1 + m)) \times V \qquad (4.1)$$

Where:

S = Subsidy for electricity

TTL = Tarif Tenaga Listrik (retail electricity price)

BPP = Biaya Pokok Penyediaan (cost of electricity)

m = margin (%)

V = Volume of electricity sold to customers.

Retail electricity price in Indonesia is differentiated into several groups accommodating several groups of customers (including household, industry, business, social, and government price groups), subsidised price and unsubsidised price, and wattage. This price is regulated and adjusted periodically, but the period of adjustment is uncertain. Before 2016, almost all electricity customers in Indonesia received subsidies, but since

2016, the government has been focusing the subsidy just on poor people (Menteri Energi dan Sumber Daya Mineral Indonesia 2016). Therefore, it is expected that in the future the government will not extend subsidy recipients so electricity subsidy for 2018 will be based on the budgeted 2017 electricity subsidy then adjusted based on inflation for the year (Inf_t). The subsidy for 2017 is around IDR 50 trillion (Republik Indonesia 2016). Electricity subsidy for 2019 and after will be based on the previous subsidy and adjusted with the inflation rate.

$$S_t = (1 + Inf_t)S_{t-1} \tag{4.2}$$

where:

S_t = Electricity subsidy year t

Inf_t = Indonesian inflation rate for year t

S_{t-1} = Electricity subsidy year t-1

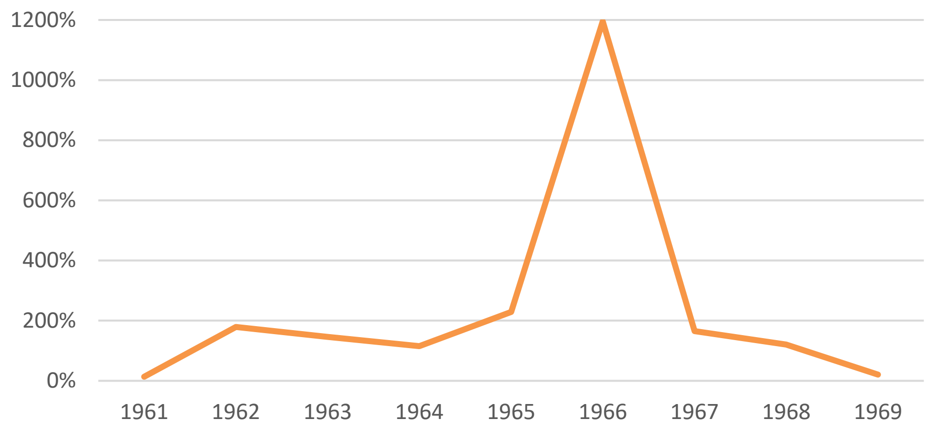
4.3.2.2 Indonesian Inflation rate

The inflation rate is measured by the Consumer Price Index (CPI), GDP (or GNP) deflator, Personal Consumption Expenditure (PCE) deflator and core CPI, a CPI which excludes highly volatile prices of goods such as energy and food, (Elliott & Timmermann 2013, p. 8). According to Rycroft (2017, p. 209), inflation refers to the change of index numbers as follows:

$$Inflation_{\ year\ i} = \frac{GDP\ deflator\ index_{\ year\ i} - GDP\ deflator\ index_{\ year\ i-1}}{GDP\ deflator\ index_{\ year\ i-1}}\ x\ 100\% \tag{4.3}$$

Indonesian inflation data has been collected from Statistics Indonesia, covering the period 1961-2016. This data series was published monthly and annually, in aggregate, and broken down by regions and sectors. The series shows that between 1961 and 2015, inflation in Indonesia averaged around 51%, with a peak of 1195% in 1966. In the 1960s, inflation was the highest on record and lifted again at the end of the 1990s (see Figure 4.7). Green (1990) argued that these past high inflation rates were due to identifiable crises. The first major one was the mid-sixties food crisis, which increased inflation to the historically high figure of 1195%.

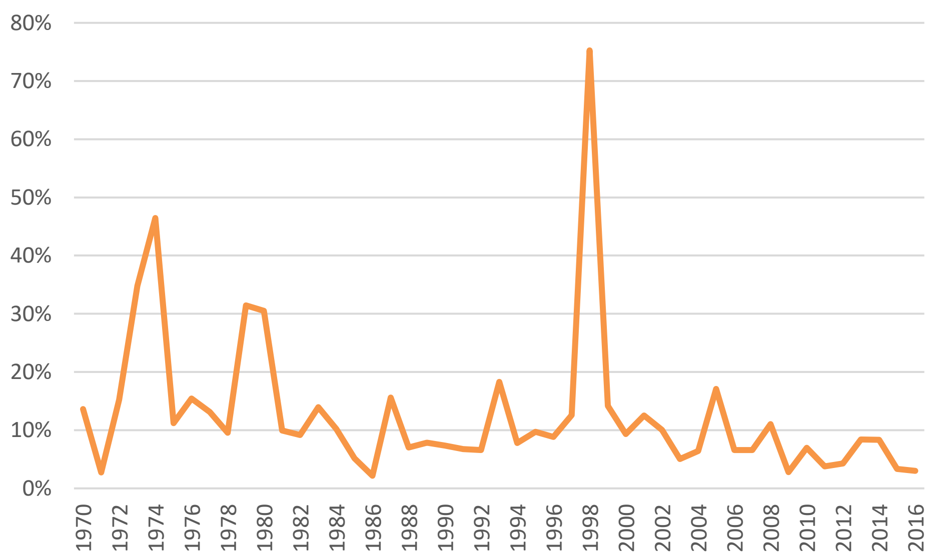
Figure 4.7 Indonesian inflation, 1961-1969



Source: Statistics Indonesia (2017).

The second one was the financial, monetary, political and social stability crisis of 1998 (Hill 1999) which escalated the inflation rate from 12.57 % the year before, and stabilised at about 75% after 1998. In the current study data used for analysis only includes inflation data for the period 2000-2016 in order to exclude the earlier periods of unstable inflation data.

Figure 4.8 Indonesian inflation, 1970-2016



Source: Statistics Indonesia (2017).

For this shorter period, 2000-2016, the inflation rates fluctuated between 2.78% to 17.11%, averaging 7.39%, which is close to the median of 6.60%. Despite a range of minimum and maximum values, in this period, the variation of Indonesian inflation was not high as the standard deviation was around half of the mean value (see Table 4.4)

Table 4.4.

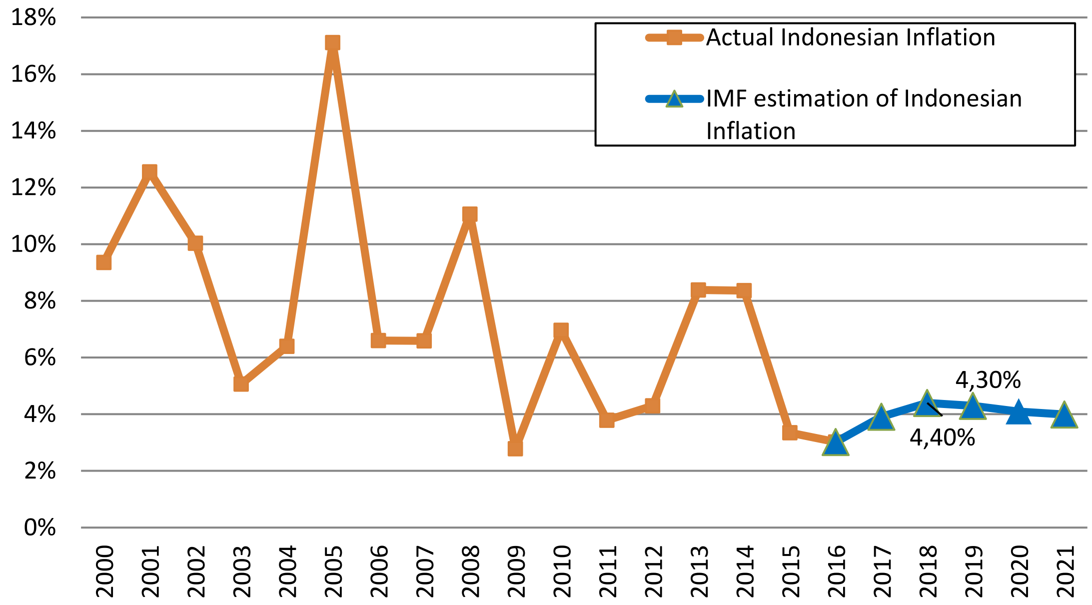
Table 4.4 Descriptive statistics of Indonesian inflation rates

	Indonesia Inflation, % (2000 – 2016)
Observations	17
Mean	7.39
Median	6.60
Minimum	2.78
Maximum	17.11
Std. Deviation	3.83
Skewness	1.00

Source: Author's calculation based on data from Statistics Indonesia (2017).

However, during this period, the Indonesia inflation rate fluctuated, increasing sharply in 2005 to a maximum value of just over 17%, and decreasing to its lowest rate of 3% in 2009. Since then, the inflation rate has moved to under 10% and even under 8%, except in 2013 and 2014. The International Monetary Fund (IMF) in 2016 established a world economic outlook that includes an estimation of Indonesian GDP deflator which can be translated into the Indonesian inflation rate. It can then be calculated that for 2018 and 2018, the IMF estimate that the Indonesian Inflation rate will be 4.40% and 4.30% respectively (see Figure 4.9).

Figure 4.9 Indonesian inflation, 2000-2021



Source: Author's calculation based on International Monetary Fund (2016); Statistics Indonesia (2017).

4.3.2.3 Estimated Electricity Subsidy

After knowing the electricity subsidy and inflation figures, the electricity subsidy for 2018 and 2018 can be calculated based on equation 4.2. It is then found that the estimated subsidy for 2018 and 2019 will be around IDR 47 trillion and IDR 49 trillion consecutively.

4.3.3 Connection Fees

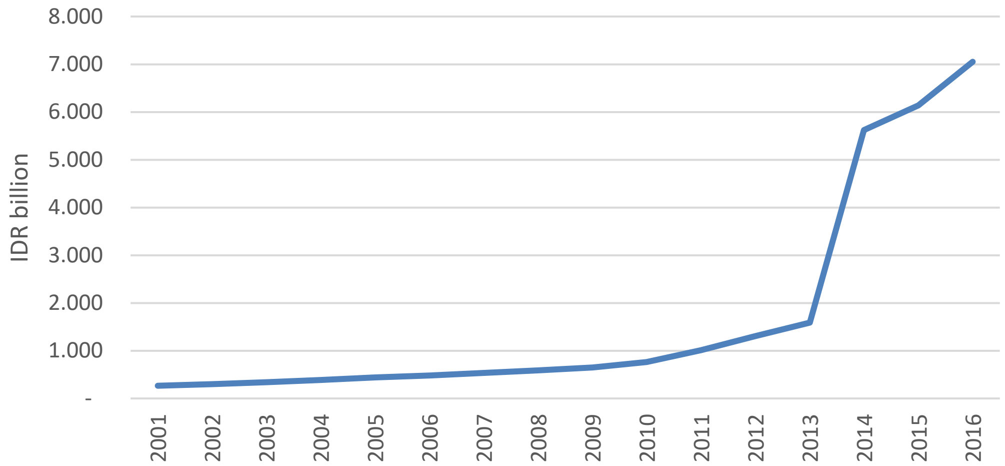
Another source of revenue for PLN is connection fees. This is a payment from new PLN customers for electricity connection, so this revenue is related to customer growth. Therefore, in projecting the connection fee for year t (CF_t), it can be calculated by multiplying customer growth year t (ΔC_t) times the previous year's connection fees (CF_{t-1}).

$$CF_t = \Delta C_t CF_{t-1} \qquad (4.4)$$

$$\Delta C_t = \frac{CF_t - CF_{t-1}}{CF_{t-1}} \qquad (4.5)$$

PLN revenues from connection fees have varied for the past 16 years. From 2001 to 2013, this fee grew steadily, but since then the fees have jumped. The most significant jump in this revenue happened in 2014 from around IDR 1.5 trillion to around IDR 5.6 trillion (see Figure 4.10).

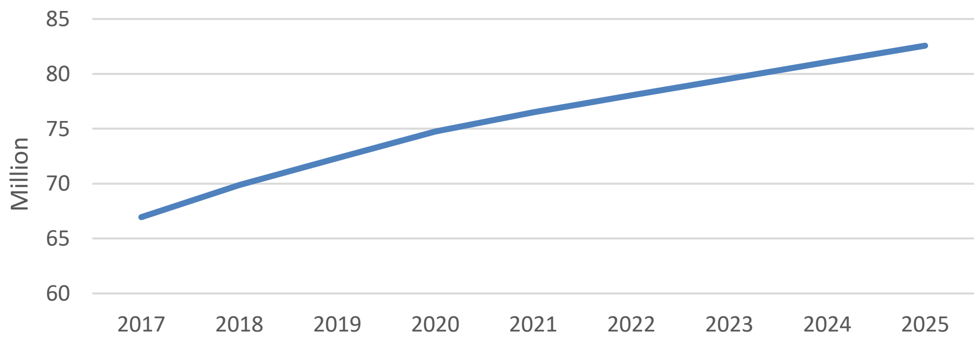
Figure 4.10 PLN customer connection fees for 2001-2016 in IDR billion



Source: PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

The Ministry of Energy and Mineral Resources and PLN have estimated the PLN number of customers until 2015. It is projected that PLN will have just under 80 million customers in 2018 and just over 70 million customers for 2019 (see Figure 4.11).

Figure 4.11 Projected number of PLN customers for 2017-2025, in millions



Source: PT Perusahaan Listrik Negara (Persero) (2016d).

From Figure 4.11, it can be calculated that customer growth for 2018 will be around 4.36% and for 2019, the customer growth will be around 3.52%. It is estimated that growth will be decreasing to 1.85% for 2025 (see Table 4.55).

Table 4.5 Predicted PLN customer growth for 2018 - 2025

	Customer growth
2018	*4.36%*
2019	*3.52%*
2020	*3.35%*
2021	*2.34%*
2022	*2.01%*
2023	*1.96%*
2024	*1.89%*
2025	*1.85%*

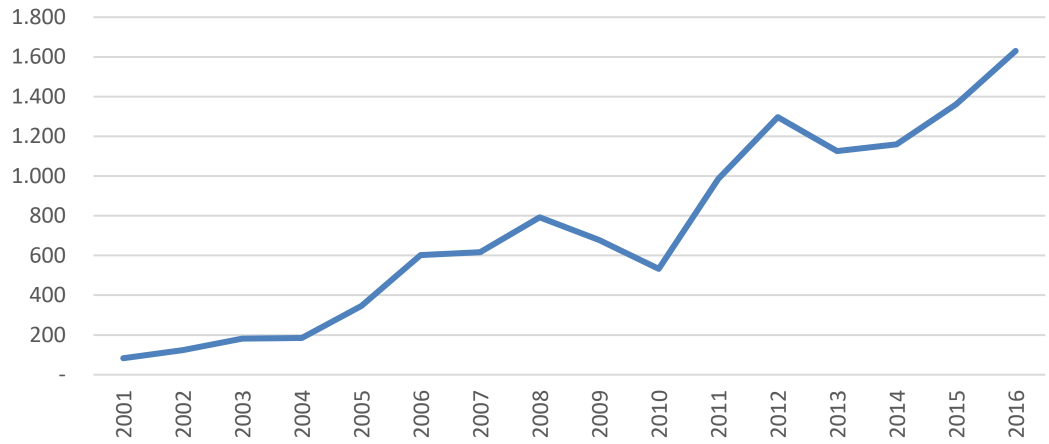
*S*ource: Author's calculations from PT Perusahaan Listrik Negara (Persero) (2016d).

From the customer connection fee revenue in Figure 4.10 and customer growth data in Table 4.55, customer connection fees for 2018 and 2019 can be calculated based on Equation 4.4. The result is the connection fees for 2018 will be IDR 7,369 billion and for 2019 will be around IDR 7,691 million.

4.3.4 Other Revenue

Apart from connection fees, PLN also receives other revenue. During 2001-2016 this revenue fluctuated but showed an upward trend. It grew tremendously as for 2016, PLN had 20 times the amount of other revenue compared to 2001 (see Figure 4.12).

Figure 4.12 PLN Other revenue for 2001-2016



Source: PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

As the sales of electricity subsidy projections are known, other components of the income statement including Other Revenue, Operating Expenses, and Non-Operating Income/(Loss), can be predicted based on the common size method (Charnes 2007). Under this method, the proportion of each of the components to the sales plus electricity subsidy is examined, based on the historical data. It was found that this proposition of Other Revenue to the sum of Sale of Electricity fluctuated from 0.237% to 0.581% with an average of 0.439%.

Figure 4.13 Proportion of PLN other revenue to the sum of sale of electricity and electricity subsidy for 2001-2016

Source: Author's calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

As this proportion was not certain, the historical data was fitted using a Crystal Ball application to find its probability distribution during the period and limited to the minimum value of 0, as a negative value for this account is impossible. It was then found based on the best goodness of fit parameters that the other revenue follows a Beta probability distribution with a median value of 0.44%, a minimum value of 0.21%, a maximum value of 0.58% of the sum of the Sale of Electricity and Electricity Subsidy, an Alpha of 1.36 and a Beta of 0.99 (see Figure 4.15).

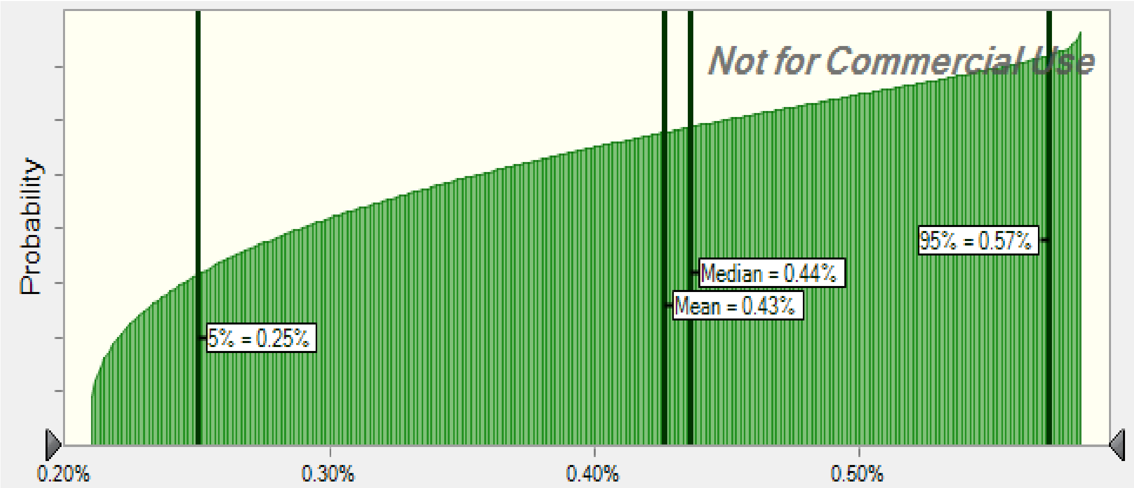
Figure 4.14 Goodness-of Fit result of the proportion of other revenue to the sum of sales of electricity and electricity subsidy

Distribution	A-D	A-D P-Value	K-S	K-S P-Value	Chi-Square	Chi-Square P-Val	Parameters
Beta	.1432	---	.0941	---	2.5000	---	Minimum=0.21%,Maximum=0.59%,Alpha=1.358
Weibull	.1982	0.801	.1125	0.785	1.5000	---	Location=-0.03%,Scale=0.49%,Shape=4.94468
Min Extreme	.2163	0.832	.1277	0.647	.5000	0.480	Likeliest=0.48%,Scale=0.09%
Normal	.2570	0.680	.1206	0.729	1.5000	0.221	Mean=0.43%,Std. Dev.=0.11%
Lognormal	.2572	0.587	.1206	0.657	1.5000	---	Location=-433.01%,Mean=0.43%,Std. Dev.=0.1
Triangular	.2744	---	.1485	---	1.0000	---	Minimum=0.14%,Likeliest=0.58%,Maximum=0.5
Logistic	.2815	0.582	.1297	0.519	1.5000	0.221	Mean=0.43%,Scale=0.06%
Gamma	.2945	0.796	.1262	0.831	1.5000	---	Location=-2.80%,Scale=0.00%,Shape=999
Uniform	.3950	0.700	.1586	0.694	.5000	0.480	Minimum=0.22%,Maximum=0.60%
Max Extreme	.4603	0.261	.1657	0.230	1.5000	0.221	Likeliest=0.38%,Scale=0.10%
Student's t	.7965	---	.1903	---	4.5000	---	Midpoint=0.43%,Scale=0.05%,Deg. Freedom=1
BetaPERT	2.0466	---	.1919	---	1.5000	---	Minimum=0.21%,Likeliest=0.44%,Maximum=0.5
Pareto	2.2092	---	.2950	---	6.5000	0.011	Location=0.23%,Shape=1.68223
Exponential	4.2355	0.000	.4259	0.000	34.0000	0.000	Rate=23,436.53%

Source: Author’s calculation from PLN Annual Reports 2001-2016.

For 2018 and 2019, the average number of this proportion will be 0.43%, and a median of 1.44%. There is 45% chance that this proportion will be between 0.44% - 0.57% and a 5% chance that this proportion will be between 0.21% - 0.25% (see Figure 4.15).

Figure 4.15 Probability distribution of the proportion of PLN other revenue to the Sum of Sale of Electricity and Electricity Subsidy



Source: Author's calculation.

4.3.5 Operating Expenses

The company's primary source income is from the sale of electricity, but the Sales of Electricity account in its financial statements does not reflect all of the sales due to the electricity subsidy it receives. In its income statements, the primary cash flows are from sales of electricity and electricity subsidy. Up to 2014, the subsidy was categorised as revenue, but from its 2015 annual report, PLN reclassifies it as a separate line item after the net result (PT Perusahaan Listrik Negara (Persero) 2016b). The electricity payment is shared by the customers and the government through the subsidy. Therefore, in this study, to get the total sales of electricity data, the Sales of Electricity data is added to the electricity data for the same year.

Currently, more than 80% of PLN revenue is consumed by its operating expenditures. On average, more than 95% of it revenue is needed to pay operating expenses such as fuel and lubricants, purchased electricity, lease costs, maintenance, personnel and depreciation (PT Perusahaan Listrik Negara (Persero) 2017) (see Table 4.6).

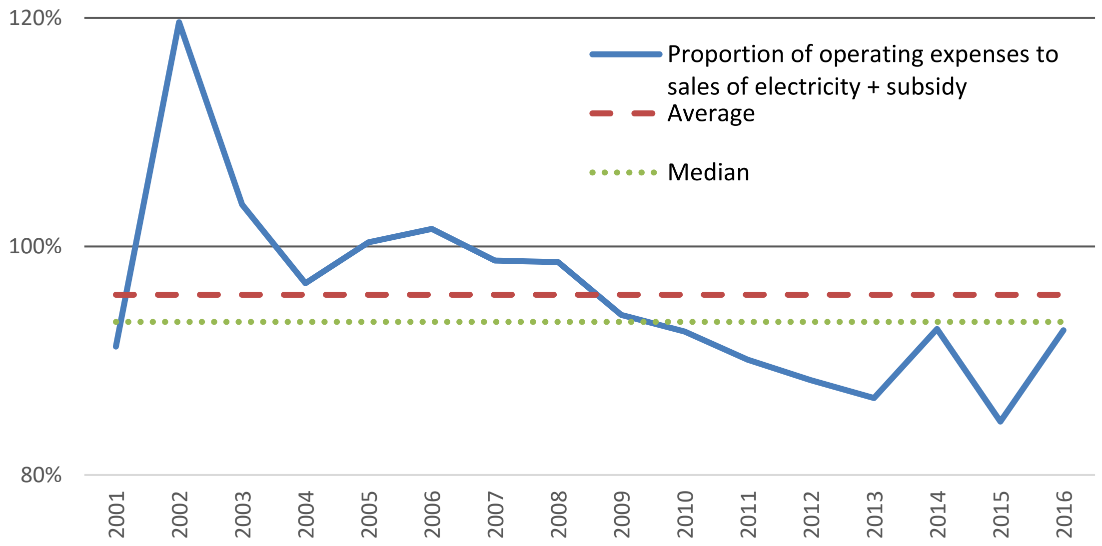
Table 4.6 Descriptive statistics of operating expenses to sales of electricity and subsidy ratio for the period 2001 - 2016

Observations	16
Mean	95.78%
Median	93.40%
Minimum	84.68%
Maximum	119.63%
Std. Deviation	8.36%
Skewness	1.50

Source: Author's calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

A common size analysis, by finding the proportion of the sum of Sale of Electricity and Electricity Subsidy, was also conducted to calculate 2018 and 2019 operating expenses. Operating expenses have been the most substantial cost PLN has to pay. The proportion of operating expenses to sales of electricity and subsidy (operating expenses to total sales of electricity) fluctuates from around 85% to 120% (see Table 4.6). If this ratio is more than 100%, it means that PLN is making a loss selling as the total electricity payment received from the government and the customers cannot even pay the operating cost. The historical data shows that for the last 16 years, PLN has done this loss selling at least three times: in 2002, 2005 and 2006 (see Figure 4.16).

Figure 4.16 Proportion of PLN operating expense to the sum of sales of electricity and electricity subsidy



Source: Author's calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

A majority of observations on the proportion of operating expenses to the sum of sales of electricity and electricity subsidy were under 100%, indicating that PLN has been able to cover its costs, and as shown in Figure 4.11, this has been declining from around 2006. Therefore, there is a high probability that in the future the revenue can cover its operating expenditures.

To estimate the future value of this proportion, the proportion data from 2001-2016 were fitted to find its probability distribution. In Crystal Ball software, this is done by selecting the 'Fit Distribution To Data' function. The result is a table consisting of a Goodness of Fit value to be considered to pick the closest probability distribution. For the proportion of operating expenses to the sum of sales of electricity and electricity subsidy, the best goodness of fit is a maximum extreme distribution with likeliest of 92.25% and scale of 5.92% (see Figure 4.17).

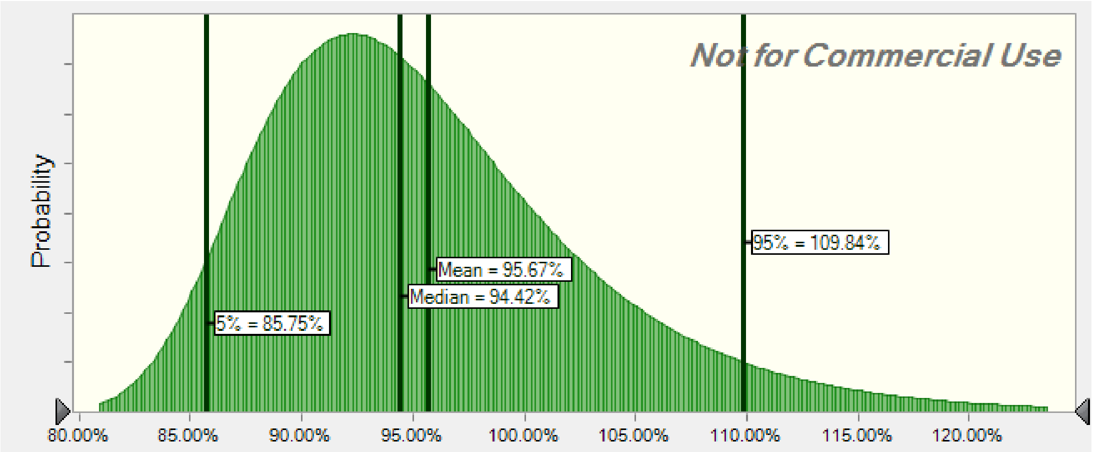
Figure 4.17 Goodness-of Fit result of the proportion of operating expenses to the sum of sales of electricity and electricity subsidy

Distribution	A-D	A-D P-Value	K-S	K-S P-Value	Chi-Square	Chi-Square	Parameters
Max Extreme	.1753	0.927	.0989	0.934	.5000	0.480	Likeliest=92.25%,Scale=5.92%
Lognormal	.1802	0.756	.0966	0.888	1.5000	---	Location=78.26%,Mean=95.89%,Std. Dev.=8.49
Gamma	.2079	1.000	.1022	1.000	1.5000	---	Location=83.00%,Scale=5.17%,Shape=2.4702
Logistic	.3080	0.507	.1266	0.561	.5000	0.480	Mean=95.08%,Scale=4.43%
Weibull	.3691	0.441	.1331	0.653	1.5000	---	Location=83.03%,Scale=15.45%,Shape=1.6963
Student's t	.4125	---	.1558	---	.5000	---	Midpoint=95.78%,Scale=7.22%,Deg. Freedom=
Normal	.5307	0.147	.1460	0.422	.5000	0.480	Mean=95.78%,Std. Dev.=8.36%
Pareto	1.0886	---	.2349	---	3.5000	0.061	Location=84.00%,Shape=7.8243
Triangular	1.1832	---	.2609	---	3.5000	---	Minimum=83.62%,Likeliest=84.68%,Maximum=
Min Extreme	1.3393	0.000	.1990	0.059	6.5000	0.011	Likeliest=100.29%,Scale=10.35%
Beta	2.1954	---	.1252	---	.5000	---	Minimum=85.90%,Maximum=183.75%,Alpha=1.
BetaPERT	2.6095	---	.3087	---	5.0000	---	Minimum=83.62%,Likeliest=84.68%,Maximum=
Uniform	3.2008	0.000	.3990	0.000	11.0000	0.001	Minimum=82.62%,Maximum=121.68%
Exponential	6.2878	0.000	.5869	0.000	48.0000	0.000	Rate=104.41%

Source: Author's calculation from PLN Annual Reports 2001-2016.

The graph of this probability distribution is shown in Figure 4.18. It indicates that there is a 5% chance that the proportion value will be 110% or more and there is also a 5% chance that the proportion will be less than 85.75%. However, it is likely that this proportion value will fall around 92.5%. It is indicated that PLN only has an operating margin of 7.5% (see Figure 4.18). There is also a more than 20% chance that the PLN will spend operating expenses greater than the sum of the sales of electricity and electricity subsidy.

Figure 4.18 Probability distribution of the proportion of PLN operating expense to the sum of sales of electricity and electricity subsidy



Source: Author's calculation from PLN Annual Reports 2001-2016.

4.3.6 Non-Operating Income/(Loss)

PLN also earn income or suffer loss from non-operational activities. As a result, PLN might get profit or loss from other income, financial income and cost, (loss)/gain on foreign exchange, and extraordinary gain/(loss).

4.3.6.1 Other Income– Net

Although the government paid the difference between the electricity selling price and the financing needs through a government electricity subsidy, during 2001-2016, PLN was not always able to generate other positive income, but on the average, it is able to generate other income of IDR 1.34 trillion (see Table 4.7).

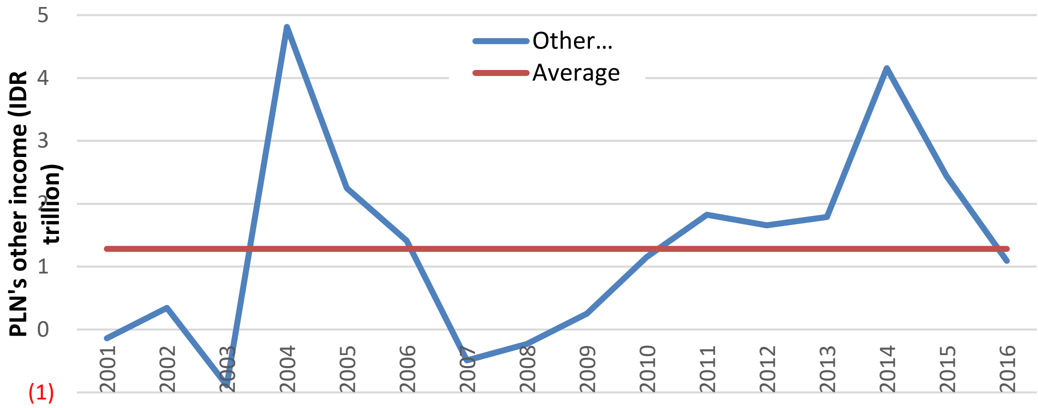
Table 4.7 Descriptive statistics of PLN other income for the period of 2001 – 2016, in IDR million

Observations	16
Mean	1,339,811
Median	1,282,304
Minimum	(887,884)
Maximum	4,812,361
Std. Deviation	1,587,630
Skewness	0.76

Source: PLN annual reports 2001-2016.

During 2001-2015, PLN suffered several losses and gained some profit in other income (see Figure 4.19). The most significant loss was nearly IDR 1 trillion, in 2003. However, in the following year, PLN generated its highest profit of just under IDR 5 trillion. Therefore, the net incomes fluctuated as was reflected by its standard deviation, which was more than the median and average value.

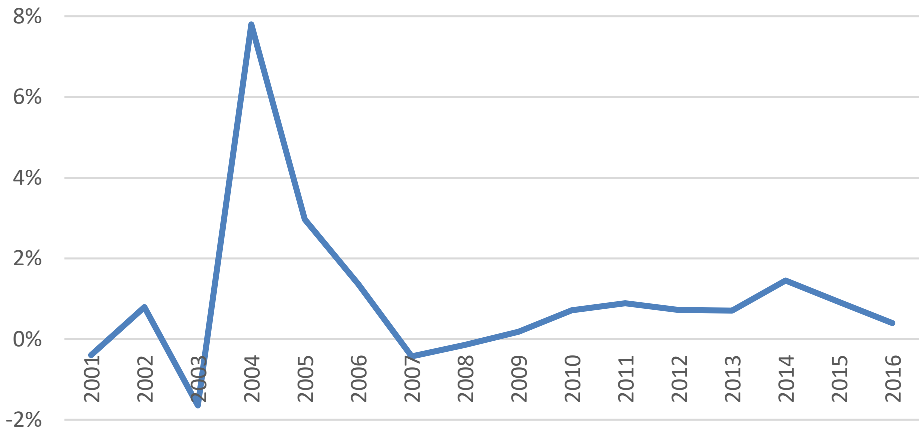
Figure 4.19 PLN other income, 2001-2016, in IDR million



Source: PLN annual reports 2001-2016.

This income proportion to the sum of Sale of Electricity and Electricity Subsidy for 2001-2016 is roughly under 2%, except for 2004, when it peaked to around 8%. When the other income jumped more than twice in 2014, the proportion of other income to the sum of Sale of Electricity and Electricity Subsidy also increased twice.

Figure 4.20 Proportion of PLN other income to the sum of Sale of Electricity and Electricity Subsidy



Source: Author's calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

The fitted historical data shows that the other income also follows a maximum extreme probability but with a median value of 0.71%, a likeliest value of just over 0 and scale of 1.26%. The other income of PLN will only be around 0.25% of the sum of Sales of Electricity and Electricity Subsidy (see Figure 4.21). In this simulation, the proportion of PLN other income to the sum of Sale of Electricity and Electricity Subsidy for 2018 and 2019 will follow this probability distribution.

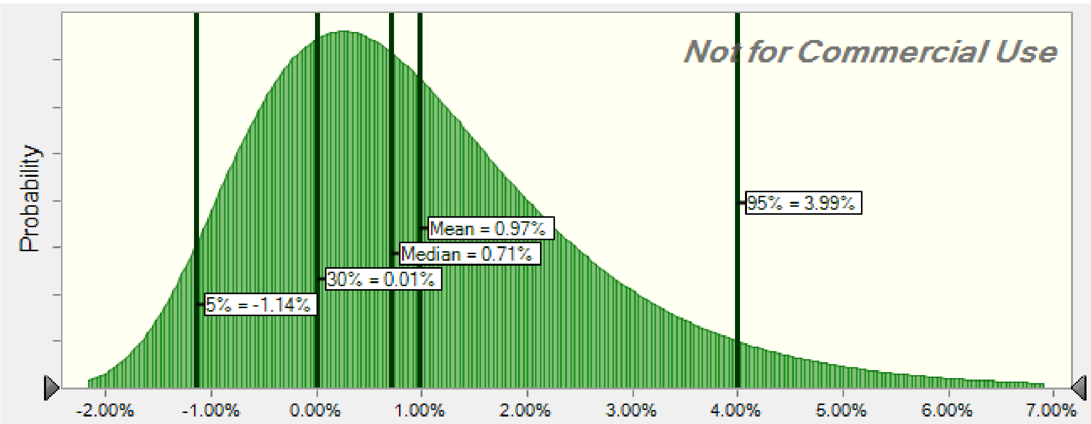
Figure 4.21 Goodness-of-Fit result of the proportion of other income to the sum of sales of electricity and electricity subsidy

Distribution	A-D	A-D P-Value	K-S	K-S P-Value	Chi-Square	Chi-Square P-Value	Parameters
Max Extreme	.7252	0.054	.1948	0.071	3.5000	0.061	Likeliest=0.25%,Scale=1.26%
Lognormal	.7837	0.000	.1996	0.016	5.5000	---	Location=-2.99%,Mean=1.02%,Std. Dev.=1.83%
Gamma	.8756	0.549	.2120	0.499	5.5000	---	Location=-2.18%,Scale=0.97%,Shape=3.28848
Logistic	1.0140	0.000	.2172	0.000	2.5000	0.114	Mean=0.79%,Scale=0.99%
Weibull	1.2882	0.000	.2862	0.000	8.5000	---	Location=-1.90%,Scale=3.61%,Shape=1.60474
Student's t	1.2947	---	.2745	---	8.5000	---	Midpoint=1.02%,Scale=1.63%,Deg. Freedom=5
Normal	1.6090	0.000	.2912	0.000	8.5000	0.004	Mean=1.02%,Std. Dev.=2.07%
Min Extreme	2.5685	0.000	.3368	0.000	17.0000	0.000	Likeliest=2.20%,Scale=2.89%
BetaPERT	2.6958	---	.3661	---	6.5000	---	Minimum=-1.93%,Likeliest=-1.65%,Maximum=1
Triangular	2.7661	---	.4148	---	17.0000	---	Minimum=-1.93%,Likeliest=-1.65%,Maximum=1
Uniform	5.1432	0.000	.5287	0.000	13.5000	0.000	Minimum=-2.20%,Maximum=8.36%
Beta	19.2863	---	.2785	---	12.5000	---	Minimum=-0.31%,Maximum=13.68%,Alpha=0.3,
Pareto	---	---	---	---	---	---	No Fit
Exponential	---	---	---	---	---	---	No Fit

Source: Author's calculation from PLN Annual Reports 2001-2016.

There is around a 30% chance that PLN will suffer from a negative value of other income but the chance of this loss being less than -1.14% is only 5%. There is also a 5% chance that the other income will be more than 4% and a 50% chance that the other income will be more than 0.71% of the Sum of Sale of Electricity and Electricity Subsidy.

Figure 4.22 Probability distribution of proportion of PLN Other Income to the Sum of Sale of Electricity and Electricity Subsidy

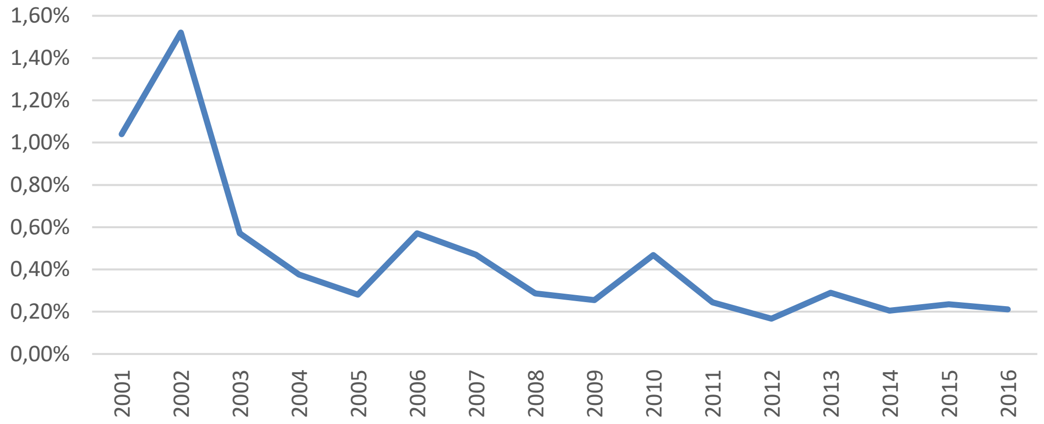


Source: Author's calculation.

4.3.6.2 Financial Income

PLN's financial income for 2001-2016 was not significant as it was mostly less than 0.60% of Sum of Sale of Electricity and Electricity Subsidy with a downward trend. Only for 2001 and 2002 was the proportion more than 1%.

Figure 4.23 Proportion of PLN financial income to the sum of Sale of Electricity and Electricity Subsidy for 2001-2016



Source: Author's calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

The proportion of financial income follows a lognormal distribution. As explained by Charnes (2007); Lee, Lee and Lee (2000), a lognormal distribution is a probability distribution where its values are positively skewed (most of the values lies near its minimum value) and have at least two parameters of mean and standard deviation. Moreover, it has to meet three conditions: there is no finite maximum value, it is positively skewed, and a log of the value will form a normal curve.

The proportion of PLN's financial income to the sum of Sale of Electricity and Electricity Subsidy for 2001-2016 follows a lognormal distribution with a median of 0.32%, a mean of 0.47% of the sum of sale of electricity and electricity subsidy, the location of 0.15%, the standard deviation of 0.51% and minimal value of 0 (see Figure 4.24). In this study, the probability for 2018 and 2019 follows the same probability distribution and the same parameters.

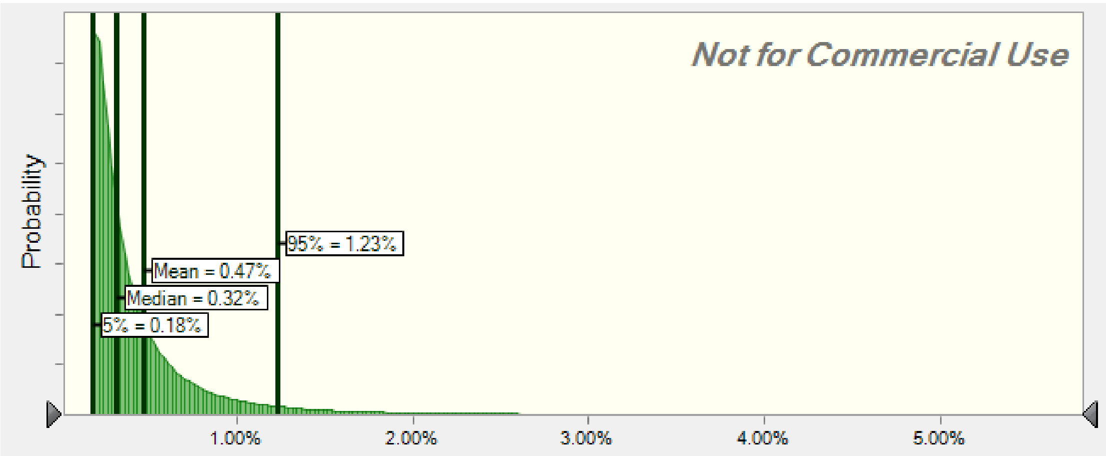
Figure 4.24 Goodness-of Fit result of the proportion of financial income to the sum of sale of electricity and electricity subsidy

Distribution	A-D	A-D P-Value	K-S	K-S P-Value	Chi-Square	Chi-Square P-Value	Parameters
Lognormal	.2030	0.785	.1351	0.520	1.5000	---	Location=0.15%,Mean=0.47%,Std. Dev.=0.51%
Pareto	.6828	---	.1992	---	3.5000	0.061	Location=0.16%,Shape=1.19411
Gamma	.8209	0.990	.2211	0.651	6.5000	---	Location=0.17%,Scale=0.56%,Shape=0.50064
BetaPERT	.9046	---	.2256	---	2.0000	---	Minimum=0.13%,Likeliest=0.17%,Maximum=1.9
Max Extreme	.9900	0.013	.2498	0.000	2.0000	0.157	Likeliest=0.32%,Scale=0.19%
Weibull	1.1172	0.338	.1486	0.000	1.5000	---	Location=0.17%,Scale=0.26%,Shape=0.81965
Logistic	1.2635	0.000	.2302	0.000	9.5000	0.002	Mean=0.39%,Scale=0.18%
Student's t	1.5983	---	.2579	---	2.0000	---	Midpoint=0.45%,Scale=0.30%,Deg. Freedom=(
Exponential	1.6253	0.024	.3104	0.000	11.5000	0.003	Rate=22,262.64%
Normal	1.7253	0.000	.2420	0.000	6.0000	0.014	Mean=0.45%,Std. Dev.=0.36%
Beta	1.7386	---	.2393	---	3.5000	---	Minimum=-4.48%,Maximum=5.38%,Alpha=100,
Min Extreme	2.3198	0.000	.3048	0.000	22.0000	0.000	Likeliest=0.65%,Scale=0.47%
Triangular	5.5606	---	.4489	---	14.0000	---	Minimum=0.13%,Likeliest=0.17%,Maximum=1.9
Uniform	7.8831	0.000	.5552	0.000	13.5000	0.000	Minimum=0.09%,Maximum=1.60%

Source: Author's calculation from PLN Annual Reports 2001-2016.

The average proportion of PLN financial income to the Sum of Sale of Electricity and Electricity Subsidy is 0.47% with a median of 0.32%. There is a 5% chance that the proportion will be up to 0.18% and a 5% chance also that this proportion will be more than 1.23%.

Figure 4.25 Probability distribution of proportion of PLN financial income to the sum of Sale of Electricity and Electricity Subsidy

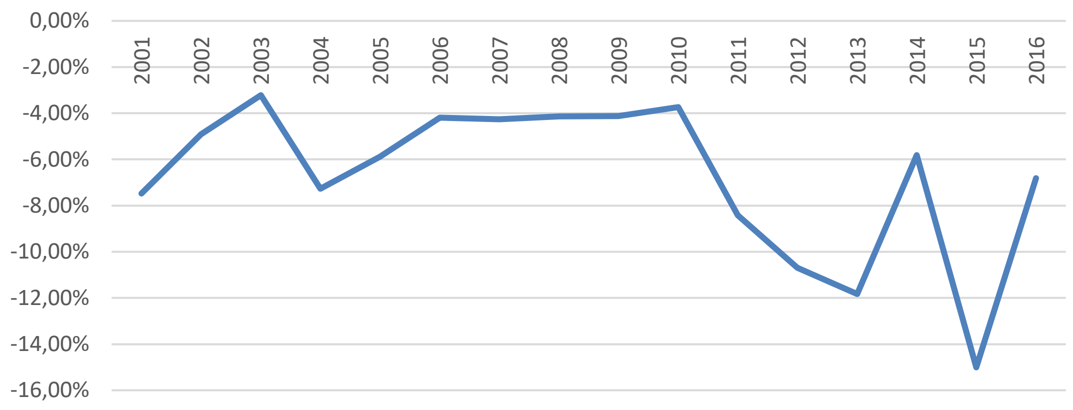


Source: Author's calculation.

4.3.6.3 Financial Cost

The proportion of PLN financial cost to the Sum of Sale of Electricity and Electricity Subsidy was stable at around -4% for 2006-2010, but it mostly fluctuated from around -3% to around -15% (see Figure 4.26). The magnitude of financial cost is apparently more than the financial income so if financial income /(cost) was presented as a net amount it would be likely to be negative.

Figure 4.26 Proportion of PLN financial cost to the sum of Sale of Electricity and Electricity Subsidy



Source: Author's calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

Every year, PLN has to spend a financial cost following a minimum extreme distribution with a median of -5.77%, a likeliest of -5.12%, the scale of 1.77% and the maximum value of 0 of the sum of the sale of electricity and electricity subsidy (see Figure 4.27). This probability distribution with the same parameters will be adopted for the 2018 and 2019 financial cost proportion.

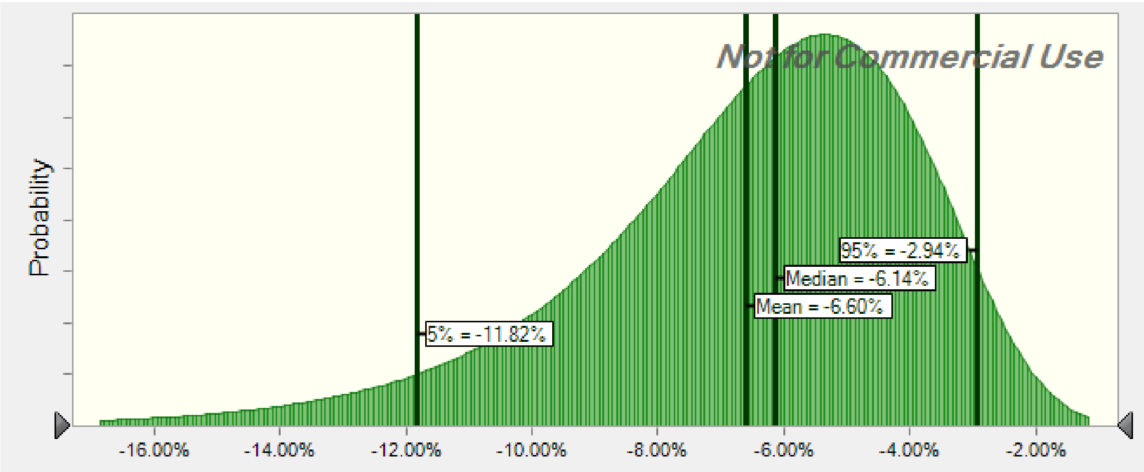
Figure 4.27 Goodness-of Fit result of the proportion of financial cost to the sum of sales of electricity and electricity subsidy

Distribution	A-D	A-D P-Value	K-S	K-S P-Value	Chi-Square	Chi-Square P-Value	Parameters
Min Extreme	.4770	0.240	.1797	0.131	1.5000	0.221	Likeliest=-5.34%,Scale=2.18%
Weibull	.4778	0.165	.1797	0.109	1.5000	---	Location=-2,188.21%,Scale=2,182.87%,Shape=
Logistic	.6201	0.062	.1575	0.199	1.5000	0.221	Mean=-6.32%,Scale=1.85%
Student's t	.7739	---	.1668	---	1.5000	---	Midpoint=-6.74%,Scale=3.22%,Deg. Freedom=
Normal	.7815	0.030	.1643	0.240	1.5000	0.221	Mean=-6.74%,Std. Dev.=3.33%
Gamma	.8235	0.060	.1694	0.344	1.5000	---	Location=-110.54%,Scale=0.10%,Shape=999
Lognormal	1.0774	0.000	.2048	0.010	1.5000	---	Location=-26.03%,Mean=-6.68%,Std. Dev.=3.8
Max Extreme	1.2234	0.000	.2205	0.021	5.5000	0.019	Likeliest=-8.51%,Scale=3.81%
BetaPERT	1.3822	---	.1786	---	2.5000	---	Minimum=-18.30%,Likeliest=-3.22%,Maximum=
Triangular	1.5613	---	.2525	---	5.0000	---	Minimum=-18.30%,Likeliest=-3.22%,Maximum=
Beta	2.0973	---	.1316	---	2.5000	---	Minimum=-17.77%,Maximum=-3.66%,Alpha=1.
Uniform	3.5438	0.000	.3738	0.000	6.5000	0.011	Minimum=-15.70%,Maximum=-2.53%
Pareto	---	---	---	---	---	---	No Fit
Exponential	---	---	---	---	---	---	No Fit

Source: Author's calculation from PLN Annual Reports 2001-2016.

The proportion of the financial cost to the sum of Sale of Electricity and Electricity Subsidy is likely to be around -5.34% with an average value of -6.60%. There is a 45% chance that proportion will be between -6.14% to -2.94% but there is a 5% chance that the proportion will be less than -11.82%.

Figure 4.28 Probability distribution of proportion of PLN financial cost to the sum of Sale of Electricity and Electricity Subsidy

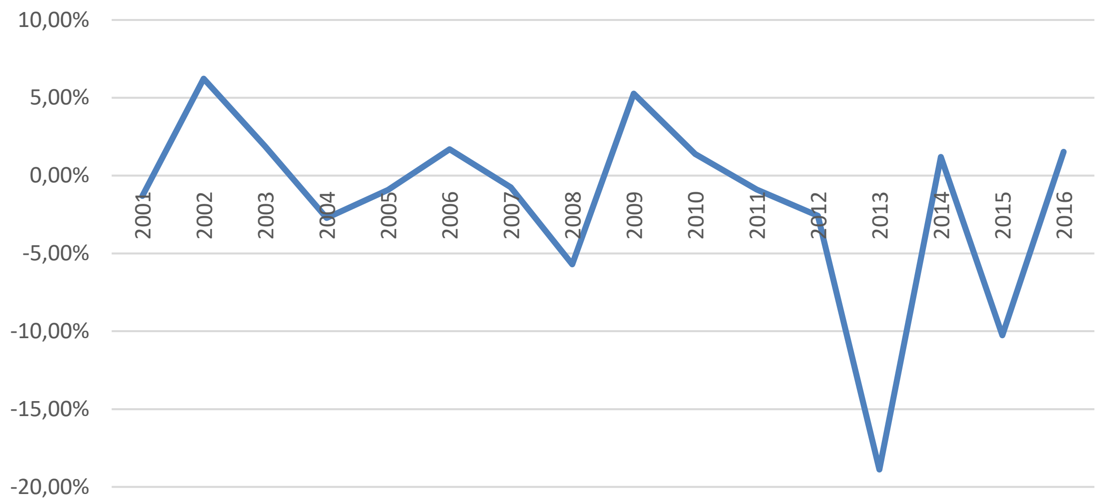


Source: Author's calculation.

4.3.6.4 Gain/(Loss) on Foreign Exchange

PLN is exposed to foreign exchange since PLN purchases electricity from IPPs in USD but sells the electricity in IDR. This risk can make PLN experience either an additional gain or loss, but PLN mostly suffered losses from foreign exchange during 2001-2016, with the worst loss being -18.88% of the sum of Sale of Electricity and Electricity Subsidy. Meanwhile the biggest gain was in 2002, of around 6% (see Figure 4.29).

Figure 4.29 Proportion of PLN gain/(loss) on foreign exchange to the sum of Sale of Electricity and Electricity Subsidy



Source: Author’s calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

The proportion of PLN gain/(loss) from the foreign exchange rate to the sum of Sale of Electricity and Electricity Subsidy follows a minimum extreme probability distribution with a median of -0.40%, a likeliest of 1%, and a scale of almost 4% of the sum of sales of electricity and electricity subsidy (see Figure 4.30). Therefore, for 2018 and 2019, the proportion will follow this probability distribution and parameters.

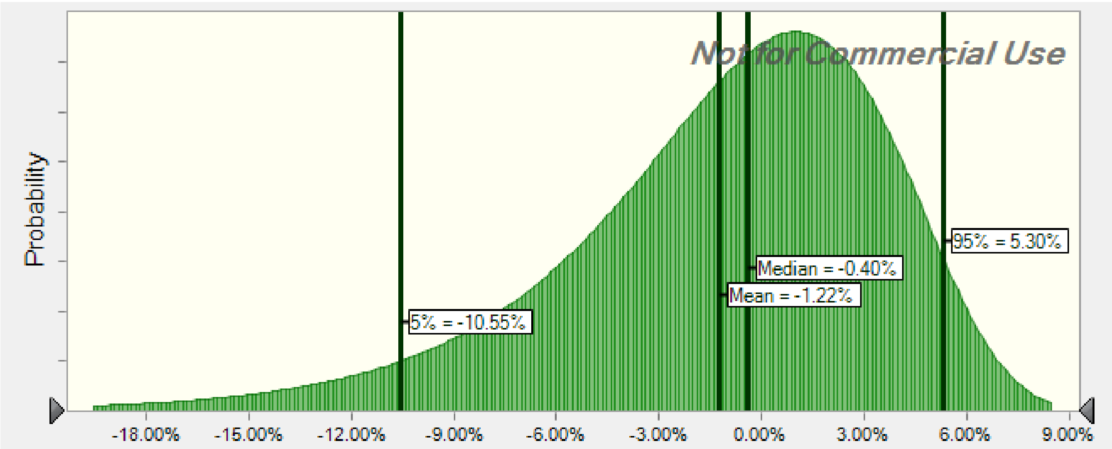
Figure 4.30 Goodness-of Fit result of the proportion of PLN gain/(loss) on foreign exchange to the sum of sales of electricity and electricity subsidy

Distribution	A-D	A-D P-Value	K-S	K-S P-Value	Chi-Square	Chi-Square P-Value	Parameters
Min Extreme	.4307	0.310	.1584	0.291	2.5000	0.114	Likeliest=0.92%,Scale=4.09%
Weibull	.4314	0.222	.1582	0.254	2.5000	---	Location=-4,083.09%,Scale=4,084.01%,Shape=
Logistic	.6402	0.054	.1707	0.107	2.5000	0.114	Mean=-0.89%,Scale=3.14%
Student's t	.8343	---	.2269	---	8.5000	---	Midpoint=-1.55%,Scale=5.19%,Deg. Freedom=
Normal	.9603	0.000	.2365	0.011	8.5000	0.004	Mean=-1.55%,Std. Dev.=6.07%
Gamma	1.0009	0.022	.2400	0.021	8.5000	---	Location=-192.05%,Scale=0.19%,Shape=999
Lognormal	1.3889	0.000	.2755	0.000	8.5000	---	Location=-42.36%,Mean=-1.45%,Std. Dev.=7.1
Triangular	1.6029	---	.3211	---	16.5000	---	Minimum=-25.89%,Likeliest=6.23%,Maximum=
Max Extreme	1.7080	0.000	.2832	0.000	8.5000	0.004	Likeliest=-4.87%,Scale=7.61%
Uniform	3.6661	0.000	.4412	0.000	9.0000	0.003	Minimum=-20.36%,Maximum=7.71%
Beta	8.5766	---	.2504	---	2.5000	---	Minimum=-39.21%,Maximum=4.03%,Alpha=4.4
BetaPERT	8.7122	---	.2408	---	3.5000	---	Minimum=-39.21%,Likeliest=4.03%,Maximum=
Pareto	---	---	---	---	---	---	No Fit
Exponential	---	---	---	---	---	---	No Fit

Source: Author’s calculation from PLN Annual Reports 2001-2016.

From foreign exchange, there is a more than 50% chance that PLN will suffer losses with a 5% chance that the loss will be more than -10.55%. On the positive side, there is a 5% chance that PLN will gain more than 5.30% of the sum of Sale of Electricity and Electricity Subsidy.

Figure 4.31 Probability distribution of proportion of PLN gain/(loss) on foreign exchange to the sum of Sale of Electricity and Electricity Subsidy

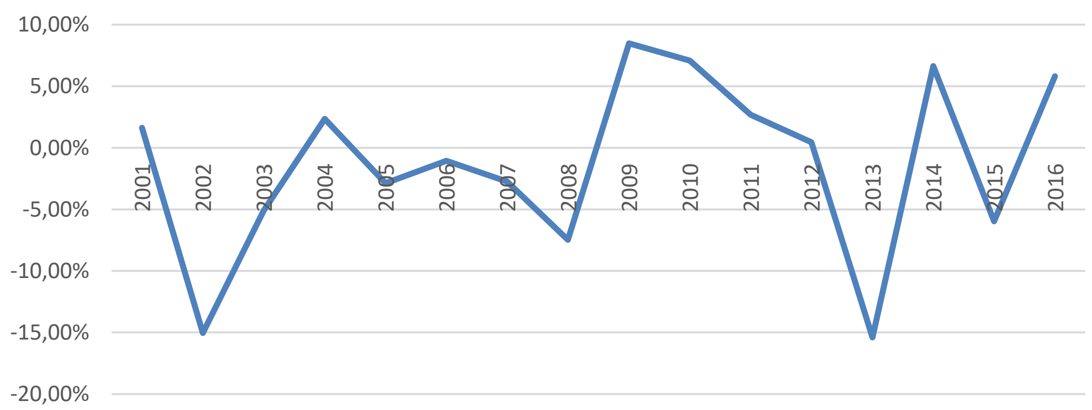


Source: Author's calculation.

4.3.6.5 Extraordinary Gain/(Loss)

During 2001-2016, PLN received gain or loss from extraordinary items which fluctuated from a loss of around -15% to a gain of around more than 8% (see Figure 4.32). This proportion is not specified so in conducting the common size method the proportion is fitted to the best probability distribution.

Figure 4.32 Proportion of PLN extraordinary gain/(loss) to the sum of Sale of Electricity and Electricity Subsidy



Source: Author's calculation based on PT Perusahaan Listrik Negara (Persero) (2003, 2005, 2007, 2009, 2011, 2013, 2015, 2016b, 2016d, 2017).

After fitting the proportion data, it was found that this proportion follows a lognormal distribution with a median of 0.17%, and a mean of 0.55% of the sum of sales of electricity and electricity subsidy with a location of -0.55% and standard deviation of 1.28% (see Figure 4.33). This probability distribution with its parameters applies for the proportion for this study.

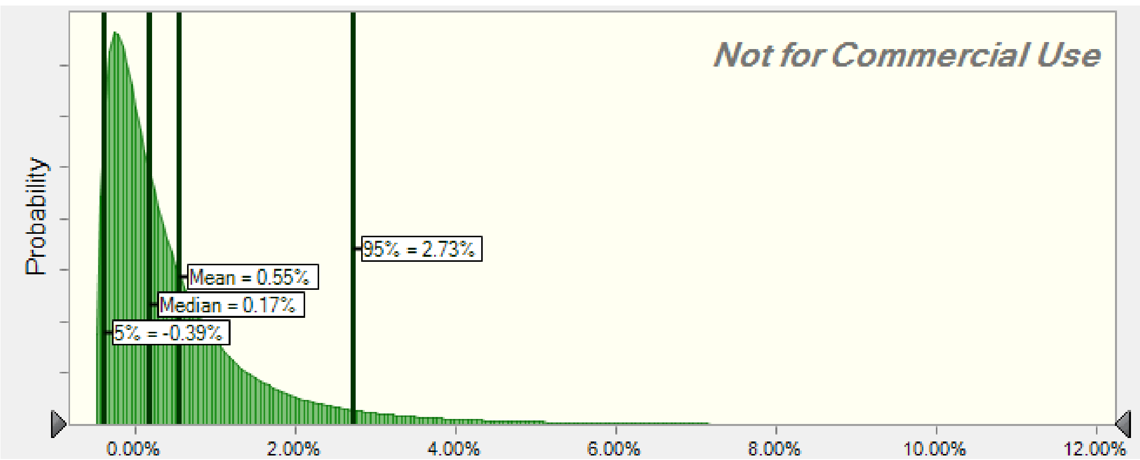
Figure 4.33 Goodness-of Fit result of the proportion of extraordinary gain/(loss) to the sum of sales of electricity and electricity subsidy

Distribution	A-D	A-D P-Value	K-S	K-S P-Value	Chi-Square	Chi-Square P-Value	Parameters
Lognormal	2.1222	0.000	.3643	0.000	17.0000	---	Location=-0.55%,Mean=0.55%,Std. Dev.=1.28%
Gamma	2.6985	0.000	.4455	0.000	22.5000	---	Location=-0.46%,Scale=2.25%,Shape=0.46118
Logistic	2.7336	0.000	.3564	0.000	22.5000	0.000	Mean=0.30%,Scale=0.70%
Weibull	2.8595	0.093	.3922	0.000	17.0000	---	Location=-0.46%,Scale=0.89%,Shape=0.74789
BetaPERT	2.9835	---	.4424	---	17.0000	---	Minimum=-0.63%,Likeliest=-0.46%,Maximum=
Max Extreme	3.0486	0.000	.4417	0.000	17.0000	0.000	Likeliest=0.10%,Scale=0.62%
Normal	3.0882	0.000	.4070	0.000	22.5000	0.000	Mean=0.58%,Std. Dev.=1.44%
Student's t	3.0895	---	.4352	---	22.5000	---	Midpoint=0.58%,Scale=1.14%,Deg. Freedom=
Beta	3.1261	---	.4113	---	22.5000	---	Minimum=-19.22%,Maximum=20.39%,Alpha=10
Min Extreme	3.3327	0.000	.3576	0.000	27.5000	0.000	Likeliest=1.42%,Scale=2.03%
Triangular	8.7705	---	.6101	---	21.5000	---	Minimum=-0.63%,Likeliest=-0.46%,Maximum=
Uniform	10.8442	0.000	.6268	0.000	27.5000	0.000	Minimum=-0.80%,Maximum=5.67%
Pareto	---	---	---	---	---	---	No Fit
Exponential	---	---	---	---	---	---	No Fit

Source: Author's calculation from PLN Annual Reports 2001-2016.

There is more chance for PLN to have a gain instead of loss from extraordinary operation with a greater than 50% chance that the gain will be 0.17% or more of the sum of Sale of Electricity and Electricity Subsidy. Moreover, there is a 45% chance that the proportion will be around 0.17% to 2.73%.

Figure 4.34 Probability distribution of proportion of PLN extraordinary gain/(loss) to the sum of Sale of Electricity and Electricity Subsidy



Source: Author's calculation.

4.4 Simulation Results

After inputting PLN Income Statement variables including Sale of Electricity, Electricity Subsidy, Connection Fees, Other Revenue, Operating Expenses and Non-Operating Income/(Loss) to the PLN Simulation model, it was found that in the base case PLN will make a profit of around IDR 9.6 trillion for 2018 and IDR 10 trillion for 2019. In this simulation, base case value is a deterministic output which replaces the stochastic (probabilistic) variable with its median value.

The stochastic Monte Carlo simulation produces a probabilistic output with a lower value of the centre of measurement. After 100,000 trials, it was found that the median values for the net income for 2018 and 2019 are estimated to be around IDR 6.9 trillion and IDR 7.5 trillion. The average value of the projected net income for 2018 and 2019 are close, around IDR 3.7 trillion and IDR 3.8 trillion respectively. However, there are some probabilities that PLN will not be able to make a profit as the minimum forecasted income is around IDR (248) trillion and IDR (250) trillion for 2018 and 2019 (see Table 4.8).

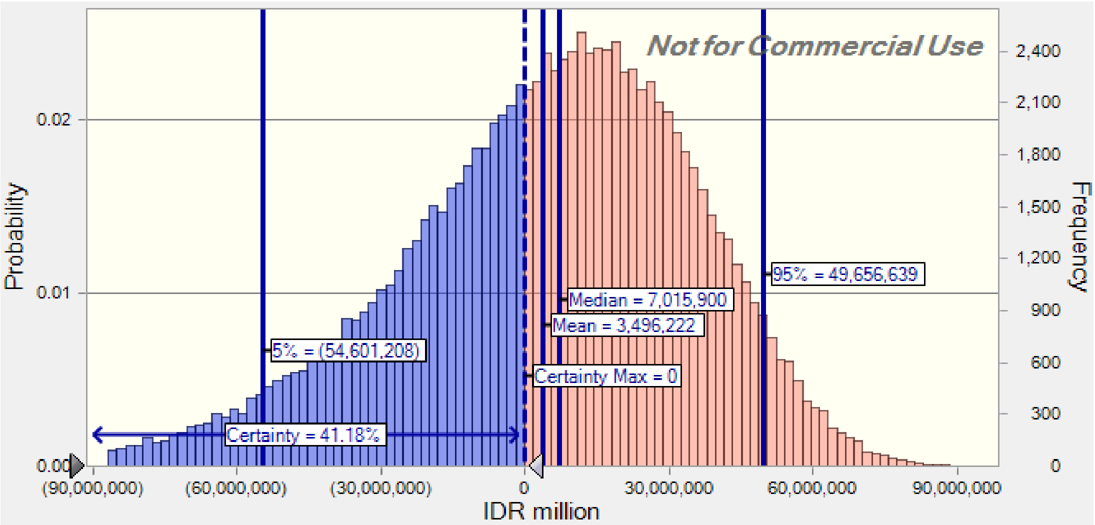
Table 4.8 Simulation results of the PLN's net income before additional electricity, 2018-2019, in IDR Million

Statistics	**Forecast values**	
	2018	2019
Trials	100000	100000
Base Case	9,623,308	10,060,590
Mean	3,686,522	3,833,658
Median	6,944,279	7,509,326
Standard Deviation	31,866,961	34,436,639
Skewness	(0.6725)	(0.6915)
Kurtosis	3.95	4.05
Coefficient of Variation	8.64	8.98
Minimum	(247,936,421)	(250,011,680)
Maximum	158,542,086	167,878,719
Mean Std. Error	100,772	108,898

Source: Author's calculation.

The minimum and maximum projected values are far less likely less likely to happen. This is because the range of possible values of the net income becomes significantly narrower under 90% certainty to make the minimum value of loss around IDR (54.6) trillion and the maximum value of profit IDR 49.7 trillion for 2018. The probability distribution of the net income will be slightly left skewed with a 41% chance the PLN will suffer from loss for its operating activities in 2018 (see Figure 4.35).

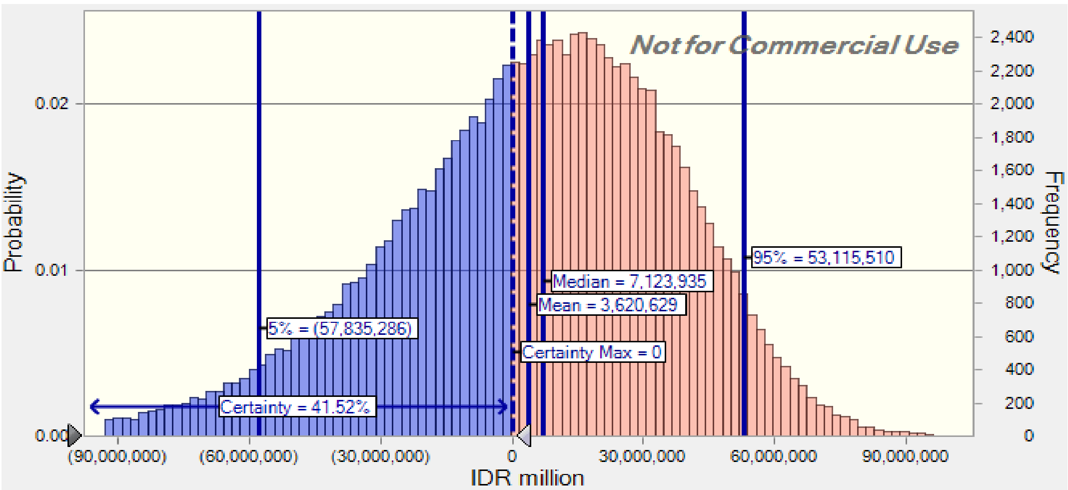
Figure 4.35 Distribution of PLN's net income before additional electricity, 2018



Source: Author's calculation.

The distribution of the PLN's income for the following year will be similar (see Figure 4.36). It is expected with 42% probability that PLN will suffer loss and, as the distribution will be left skewed, the minimum value will be on the distribution tail. Consequently, under 100% certainty, the maximum loss will be severe. However, under 90% certainty, the maximum loss will be a loss of IDR (57.8) trillion, and the maximum profit is estimated to be around IDR 53.1 trillion.

Figure 4.36 Distribution of PLN's net income before additional electricity, 2019



Source: Author's calculation.

In a geothermal IPP project, PLN purchases the generated electricity and then sells it to its retail consumers. If the selling revenue is less than the purchasing cost, from PLN's point of view, it a loss project and PLN needs to tackle some or all of the electricity payment to the IPP. In a case where PLN is building the project, the income generated from the project should be able to cover the project's debt payment. If it does not, PLN needs to tackle the debt service. However, PLN will be able to tackle those risks if it has a net income higher than the projects' deficit. If PLN suffers losses, there is no net income available to tackle the payment, and all of those risks will be transferred to the government. If PLN can make a profit, but less than their financial payment obligation, the government will pay the rest and it will be recorded as government guarantee exposure.

For 2018 and 2019, there is a chance that PLN will suffer losses so that it will not have a fund to tackle electricity payments to IPPs and to service projects' debts. The maximum net income PLN can achieve for 2018 and 2019 is projected to be IDR 158.5 trillion and IDR 167.9 trillion consecutively. Under 90%, this projected maximum income will be much lower, at IDR 49.7 trillion and IDR 53.1 trillion for those years (see Table 4.9).

Table 4.9 PLN net income /(loss) for 2018 and 2019 in IDR million

Year	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
2018	3,496,222	7,015,900	(247,936,421)	158,542,086	(54,601,208)	49,656,639
2019	3,620,629	7,123,935	(250,011,680)	167,878,719	(57,835,286)	53,115,510

4.5 Chapter Summary

This chapter simulates the first simulation model which is a simulation of the PLN Income Statement comprising revenue, operating expenses, electricity subsidy, and non-operating income. The most significant revenue for PLN is from the sale of electricity, but aside from revenue, PLN also earns an electricity subsidy. The government has projected the PLN sale of electricity and also committed not to add more electricity subsidies so the number of electricity subsidies for 2018 and 2019 will be based on the last number of budgeted subsidies, in the year 2017. With common size method, the sum of the sale of electricity and electricity subsidies becomes the basis to forecast other revenue, operating expenses, and non-operating income/(loss). After conducting the simulation, it was found that for 2018, there will be just under 60% probability that PLN will make a profit. PLN is expected to have an average profit of around IDR 3.5 trillion and median of around IDR 7 trillion for 2018 and around IDR 3.6 trillion and median of IDR 7.1 trillion for 2019. The following chapter will discuss the second simulation model in this study, the Business Viability Simulation Model, which assesses the financial impact for PLN when it purchases electricity from geothermal projects owned by IPPs.

Chapter 5
Business Viability Simulation Model

5.1 Introduction

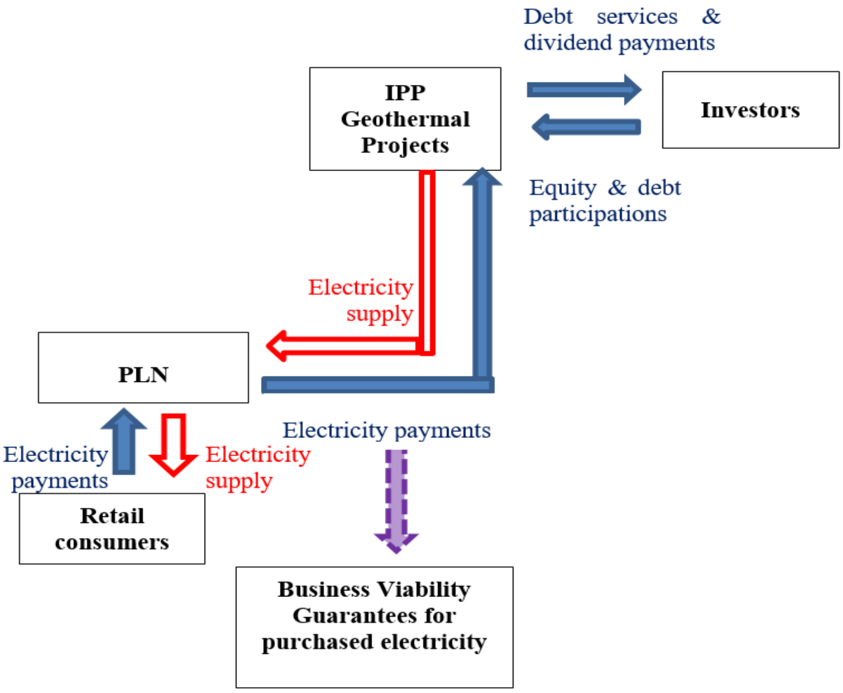
The previous chapter presented the first simulation model in this study, which is simulating PLN's Income Statement for 2018 and 2019. It was found that for that year, there will be just over a 40% chance that PLN will suffer a loss but the mean and median values indicate that PLN will make a profit.

This chapter presents a simulation model for PLN when there is cooperation between PLN and IPPs, in that IPPs develop geothermal projects and PLN purchases the electricity, to understand the impacts of purchasing IPPs' electricity for PLN and then selling it to retail customers. Surplus/(deficit) from each geothermal project will be calculated. In the end, total annual surplus/(deficit) will be assessed.

5.2 Model Framework

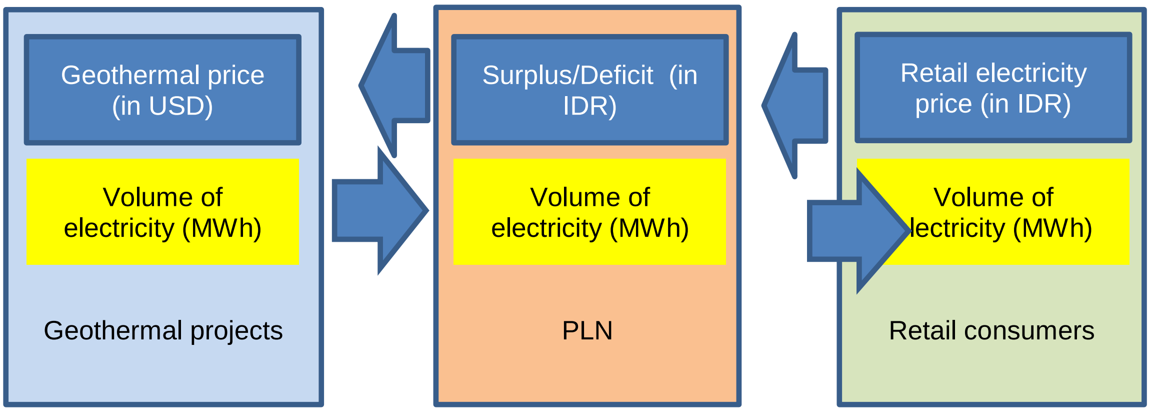
In the case of Public-Private Partnership where an IPP is developing a geothermal power plant, PLN has to purchase the electricity, and if PLN cannot pay for the purchased electricity, the government is liable to pay for it under the Business Viability Guarantee. An IPP consists of investors seeking a return: some of them are equity investors demanding dividends and the rest are debt investors willing to get debt services. To get the returns, the investors develop a geothermal power plant and sell the electricity to PLN and get payments. If PLN is unable to pay its obligation, partly or in the whole amount, the government has to take over that obligation under a Business Viability Guarantee (see Figure 5.1). Therefore, there will be a contingent liability leading to fiscal risk from the guarantee.

Figure 5.1 Business Viability Guarantee Scheme



After purchasing electricity from the IPP, PLN sells it to its retail customers. From this scheme, PLN can either get a surplus or deficit as PLN has to pay the IPPs based on a regulated geothermal price which is differentiated based on the power plant location and is in USD currency, while PLN retails the electricity based on the regulated national price which is not segregated based on location and is in IDR. If PLN gets net revenue greater than its obligation to pay the IPP, PLN gets a surplus. However, there is a chance that PLN will suffer a deficit because PLN has to pay the IPP more than it receives from its retail customers. The main cause of this condition is because the government set the geothermal price based on regional allocation, but the government set the electricity price the same for all regions. Therefore, the geothermal project will suffer a deficit in a region where PLN has to purchase the geothermal energy at a price higher than the retail electricity price.

Figure 5.2 Business Viability Guarantee Simulation Model



PLN's primary revenue is from the sale of electricity while its largest expenditure is for fuel and lubricant. As part of the sale of electricity, PLN also receives an electricity subsidy from the government. To increase electricity sales, PLN needs to get additional electricity supplies, by purchasing from IPPs or developing its owned geothermal power plants. PLN has to sign a Power Purchase Agreement (PPA) with a winning bidder of geothermal projects. After winning a geothermal project, an IPP needs to conduct the development stages before the project can be commercially operated. During these stages, IPP disburses most of the capital costs without getting any revenue. These capital expenditures will be recorded as assets that will be depreciated along the lifetime of the project by the project company. After the geothermal power plant is ready to generate electricity PLN starts purchasing the electricity (Asian Development Bank & The World Bank 2015).

5.2.1 Revenue

Electricity revenue is a function of the electricity sales and its retail price. The power plant electricity volume depends on the agreement between PLN and IPPs in the take or pay clause. This clause binds PLN to purchase 80-90% of the power plant capacity (Hasan, M & Wahjosoedibjo 2015). In a year, a power plant operates 24 hours a day, seven days a week over twelve months, or 8760 hours in a year. However, PLN does not receive all the generated electricity due to network loss of around 10% (PT Perusahaan Listrik Negara (Persero) 2017). Although PLN purchases electricity from IPPs based on a business-to-business price, PLN cannot set the price as it is regulated by a ministerial decree (Menteri Energi dan Sumber Daya Mineral Indonesia 2016). In past years, the price escalated, so in this study, the retail electricity price will be escalated based on the Indonesian inflation rate. This study will be based on IDR 1,191 per kWh, the 2017 regulated retail electricity price.

PLN cannot sell all of the electricity supply purchased from IPPs due to electricity loss. Therefore, electricity sales volume is equal to electricity purchased volume minus electricity loss. For the past 10 years the loss was around 10% so, in this model, electricity loss is assumed to be 10%, so electricity sales volume can be calculated as follows:

$$SV_t = 0.9\ PV_t \tag{5.1}$$

Where:

SV_t : Volume of electricity that can be sold to PLN retail customers, year t

PV_t : Volume of electricity PLN purchased from IPP, year t.

PLN purchases electricity from an IPP geothermal power plant based on a take or pay agreement, power plant capacity and number of hours in a year.

$$PV_t = Cap_t\ x\ TOP_t\ \text{ x } 8760 \tag{5.2}$$

Where:

Cap_t : Power Plant Capacity, year t

TOP_t : Take or Pay contract (%)

8760 : number of hours in a year

PLN get revenue from an IPP geothermal project from selling the purchased electricity to its retail customers.

$$PPR_t = SV_t\ ERP_t \tag{5.3}$$

Where

PPR_t : the power plant revenue, year t

ERP_{t-1}: electricity retail price, year t

Equations 5.1 to 5.3 can be summarised into equation 5.4 as follows

$$PPR_t = 0.9\ x\ 8760\ TOP_t\ Cap_t\ (1 + Inf_t)\ ERP_{t-1} \quad (5.4)$$

Power plant revenue (PPR_t) is a function of electricity loss (EL_t), take or pay percentage (TOP_t), power plant capacity (Cap_t), previous year electricity retail price (ERP_{t-1}), inflation rate (Inf_t) and number of hours in a year (8760).

5.2.2 Cost

From PLN's point of view cost to PLN is dependent on the geothermal electricity price and volume of purchased electricity. As the price is in USD, it is also influenced by the Indonesia exchange rate.

5.2.2.1 Formula

In the IPP geothermal model, the main cost for PLN is the purchase price charged by IPPs to PLN. While the retail price is in IDR, the purchase price is denominated in USD (Menteri Energi dan Sumber Daya Mineral Indonesia 2014). As a result, PLN is exposed to a currency rate risk: PLN will suffer losses if IDR value depreciates or USD appreciates. In this study, this risk is modelled with a Monte Carlo simulation.

The electricity purchase price charge by IPPs to PLN is denominated in USD based on Menteri Energi dan Sumber Daya Mineral Indonesia (2014) considering the bidding year and region. There are three regions, from the cheapest to the highest geothermal price: Region I for Sumatera, Java, and Bali (the most populated islands in Indonesia); Region II for Sulawesi, Nusa Tenggara, Maluku, Papua, and Kalimantan; and Region III for the remaining regions. This price will be escalated based on the U.S. inflation rate.

$$GEP_t = (1 + \ Inf\$_t)GEP_{t-1} \quad (5.5)$$

Where:

GEP_t : the regulated geothermal electricity price, year t

$Inf\$_t$: U.S. inflation, year t

For PLN, the cost for this IPP geothermal is a function of the power plant capacity, agreed take or pay percentage, and number of hours in a year.

$$IPC\$_t = Cap_t\, TOP_t\, GEP_t\, 8760 \quad (5.6)$$

Where:

$IPC\$_t$: electricity purchasing cost from the IPP in USD, year t

As an Indonesian company, PLN's financial statement is in IDR, so the electricity purchasing cost needs to be translated to IDR.

$$IPC_t = ER_t\, IPC\$_t \quad (5.7)$$

Where:

ER_t : USD to IDR average exchange rate, year t

To sum up, the electricity cost for PLN can be formulated as follows:

$$IPC_t = GEP_t\, TOP_t\, Cap_t\, 8760\, ER_t \quad (5.8)$$

Cost from an IPP geothermal project is a multiplication of the regulated geothermal electricity price (GEP_t), take or pay percentage (TOP_t), power plant capacity (Cap_t), number of hours in a year (8760), and exchange rate (ER_t).

5.2.2.2 Indonesian Foreign Exchange Rates

As PLN cost is sensitive to the foreign exchange rate and geothermal powers are tendered based on a USD denominated electricity tariff, stable exchange rates favour both IPP and PLN. This can only escalate based on exchange rates after the COD date (Asian Development Bank & The World Bank 2015, p. 46). Thus, if during construction, the IDR appreciates or fluctuates, capital cost overruns will be unavoidable.

The behaviour of the exchange rate between IDR and USD has been similar to that of the inflation rate in Indonesia. The Asian Financial Crisis of 1997 had a significant impact on the exchange rate, which increased from IDR 3,989 per USD 1 in 1997 to IDR 11,591 in early 1998, reaching the lowest point of IDR 16,650 in June 1998. These exchange rates stabilised reasonably quickly with an average of IDR 7,100 in 1999 (Bank of Indonesia 2017). As this kind of fluctuation can impair the model, this study has used the daily foreign exchange data from 2001.

During the past 17 years, on average, the USD/IDR exchange rate has fluctuated from between IDR 8,165 and IDR 14,748, with a standard deviation of 1,568. The average and median values only had a small difference of IDR 10,122 compared to IDR 9,405, respectively. The minimum value of IDR was 8,165, and the maximum value of IDR was 14,728 (see Table 5.1).

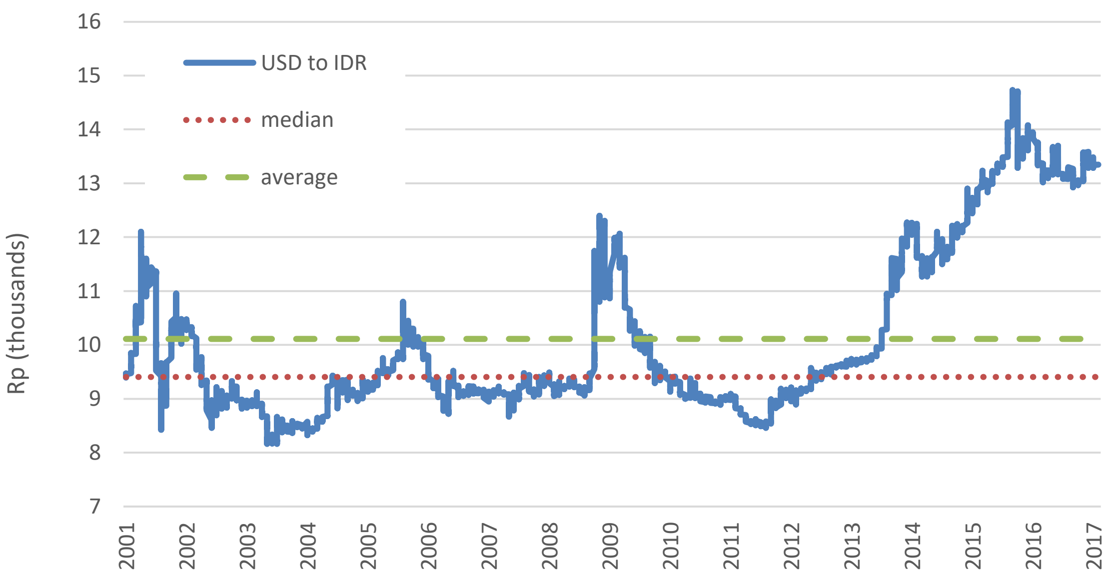
Table 5.1 Descriptive statistics of IDR to USD exchange rates 2001-2017, in IDR

Observations	3,933
Mean	10,112
Median	9,405
Mode	9,110
Minimum	8,165
Maximum	14,728
Std. Deviation	1,568
Skewness	1.14

Source: Author's calculation based on Bank of Indonesia (2017) data.

Since 2013 the foreign exchange rate has been passing the psychological limit of IDR10,000 (Stamboel 2014) with a sharp increase in the rates over 2011-2015. From that period, overall, the exchange rate seems to be in a downward trend. However, the lowest exchange rate in 2003 has not been repeated in more than a decade (see Figure 5.3).

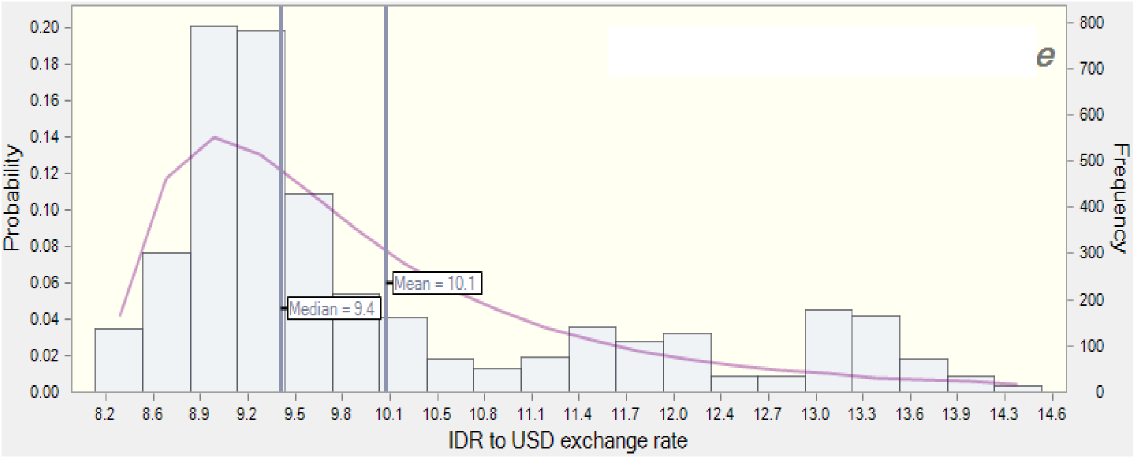
Figure 5.3 IDR to USD exchange rate, 2001-2017



Source: Author's calculation from Bank of Indonesia (2017) data.

The data was right-skewed at 1.14 (see Table 5.1), so it is indicated that the foreign currency rate is more likely to be below its mean and median value or below IDR 9,400 per USD 1 and under the psychological value. This pattern is in line with the histogram shown in Figure 5.4, and it follows a lognormal distribution.

Figure 5.4 Histogram of IDR to USD exchange rate, 2005-2017 in IDR thousands



Source: Author's calculation from Bank of Indonesia (2017) data.

The foreign currency data behaviour mimics a lognormal distribution with a location of IDR 8,000, mean of IDR 10,100 and standard deviation of IDR 1,800. This lognormal distribution has the best result of all of the goodness-of-fit test results (lowest Anderson-Darling, Kolmogorov-Smirnoff, and Chi-Square Values).

5.2.2.3 Geothermal Energy Price

Besides foreign exchange rate, PLN's cost of purchasing geothermal electricity from IPPs depends on the geothermal energy price. This price is set by the Minister of Energy and Mineral Resources. The price is differentiated based on the Commercial Operation Date (COD) year and location.

Table 5.2 Geothermal electricity price

COD year	Ceiling Price (US$ cents/kWh)		
	Region I	Region II	Region III
2015	11.8	17.0	25.4
2016	12.2	17.6	25.8
2017	12.6	18.2	26.2
2018	13.0	18.8	26.6
2019	13.4	19.4	27.0
2020	13.8	20.0	27.4
2021	14.2	20.6	27.8
2022	14.6	21.3	28.3
2023	15.0	21.9	28.7
2024	15.5	22.6	29.2
2025	15.9	23.3	29.6

Source: Menteri Energi dan Sumber Daya Mineral Indonesia (2014).

This regulation provides incentives for remote areas with higher energy prices. Region I is the most populated region, covering three main islands in Indonesia: Sumatera, Java, and Bali. Region II comprises Sulawesi, Nusa Tenggara, Halmahera, Maluku, East Papua and Kalimantan. Meanwhile, Region III is any region outside Region I and II or any area in Region I and II which is isolated or heavily dependent on a diesel power plant.

5.2.3 Surplus/(Deficit) from IPPs' Geothermal Projects

After revenues and costs are known, the surplus/(deficit) from IPPs' geothermal projects can be calculated. It is the sum of sales revenue from the IPPs geothermal projects deducted by purchasing cost from the IPP.

5.3 Geothermal Projects

This study simulates the government guarantees for geothermal power plant projects which will start to operate commercially in 2018 and 2019. The simulations are based on those projects listed in the Electricity Supply Business Plan. If the project is an IPP project, the IPP will sell its power to PLN with the geothermal price regulated under the Ministry of Energy and Mineral Resources regulation number 17 regarding geothermal power purchase by PLN. PLN then sells it based on the regulated retail price.

There are seven IPP geothermal project which received Business Viability Guarantees which will commercially operating in 2018 and 2019. Therefore, these projects will be simulated to assess the fiscal risk (see Table 5.3).

Table 5.3 Profiles of the simulated geothermal projects

No	Geothermal projects	Capacity (MW)	Region	Developer	Type of Guarantee	COD
1.	***Sarulla***	330	I	IPP	Business Viability Guarantee	2018
2.	***Lahendong VI***	20	II	IPP	Business Viability Guarantee	2018
3.	***Lumut Balai***	220	I	IPP	Business Viability Guarantee	2019
4.	***Tulehu***	20	II	IPP	Business Viability Guarantee	2019
5.	***Patuha***	55	I	IPP	Business Viability Guarantee	2019
6.	***Tangkuban Perahu 1***	55	I	IPP	Business Viability Guarantee	2019
7.	***Dieng 1***	55	I	IPP	Business Viability Guarantee	2019

Source: Menteri Energi dan Sumber Daya Mineral Indonesia (2014); Menteri Keuangan Indonesia (2011b); PT. PLN (Persero) (2015).

In this study, the guarantee will be classified based on its type, then the level of fiscal risk related to each project will be assessed based on its impact and likelihood. The level of the fiscal risk will also be grouped based on the year of occurrence.

It is assumed for this research that power plant development and construction requires five years to complete. During this period, IPPs cannot supply electricity to PLN, so PLN has no financial obligation to the IPPs yet. As it is also assumed that the first batch of power plant development was tendered in 2013, so the first new power plants will be operating commercially in 2018. In that year, PLN will start to purchase additional electricity from the IPPs then retail it to its customers.

This viability guarantee exposure calculation assesses PLN's financial capability to pay for thepower purchased from IPPs: that is, PLN needs to ensure that it has a sufficient fund to make a payment. After purchasing the electricity from IPPs, PLN then sells it to its customers. The ideal condition for this additional electricity is that the retail revenue from the electricity sales can at least pay for the electricity purchased from IPPs and other related costs. If the additional revenue cannot cover the costs, PLN must take its operational revenue (revenue from electricity businesses other than the extra electricity) to make up the deficit. However, this cross-subsidy scheme cannot be implemented if the PLN net income before the additional geothermal power plants is negative.

5.3.1 Sarulla Geothermal Project

The first project to be assessed for its profit or loss impact to PLN is Sarulla geothermal project. This geothermal project is currently the most massive geothermal project in Indonesia with 330 MW capacity. It is located in Sumatera Island, in the western part of Indonesia, so based on the Minister of Finance Regulation regarding the geothermal price, it is included in region I. Sarulla is being developed by IPP, so the developer is eligible to get a Business Viability Guarantee from the government.

5.3.1.1 Project Cost

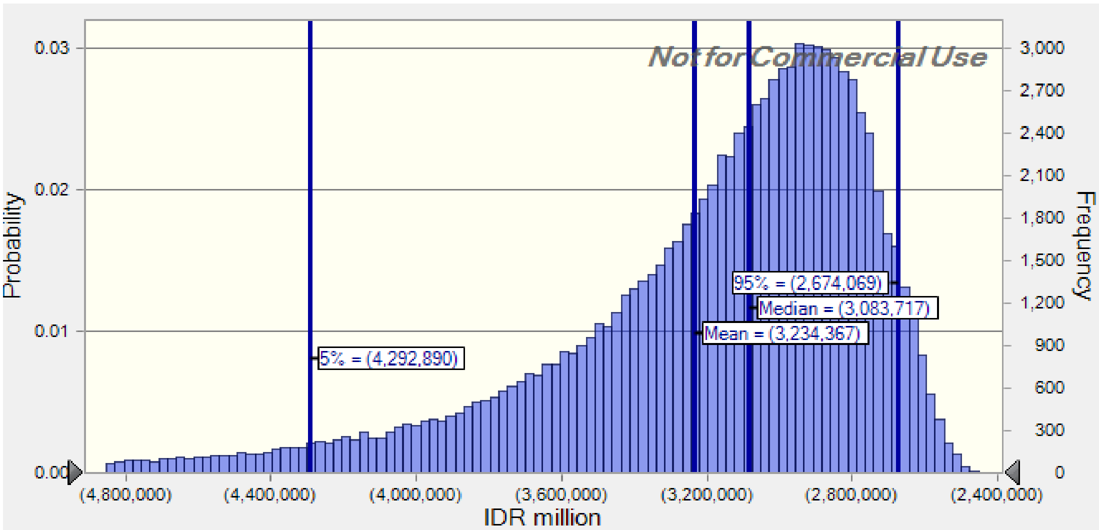
The project's commercial operating date schedule is 2018, so this study replicates the 2018 and 2019 condition. It was found that in the base case, this project will invoice PLN for electricity purchase valued at IDR 3.1 trillion for 2018 and 2019. This number is consistent with the median value as a result of running a 100,000 trials Monte Carlo simulation. The mean values provide a small variance from that amount: IDR 3.23 trillion and IDR 3.56 trillion for 2018 and 2019. The minimum electricity invoice for 2018 and 2019 will be similar, around IDR 2.5 trillion, but the maximum values are significantly different, at IDR 20 trillion and IDR 14 trillion respectively (see Table 5.4).

Table 5.4 Simulation results of electricity payment to Sarulla geothermal project for 2018 and 2019 in IDR million

Statistics	Forecast values	
	2018	2019
Trials	100,000	100,000
Base Case	(3,074,762)	(3,097,236)
Mean	(3,232,449)	(3,257,183)
Median	(3,080,281)	(3,103,808)
Standard Deviation	574,594	581,831
Skewness	(2.90)	(2.94)
Kurtosis	19.16	19.94
Coefficient of Variation	(0.1778)	(0.1786)
Minimum	(11,794,075)	(12,285,090)
Maximum	(2,453,504)	(2,474,938)
Mean Std. Error	1,817	1,840

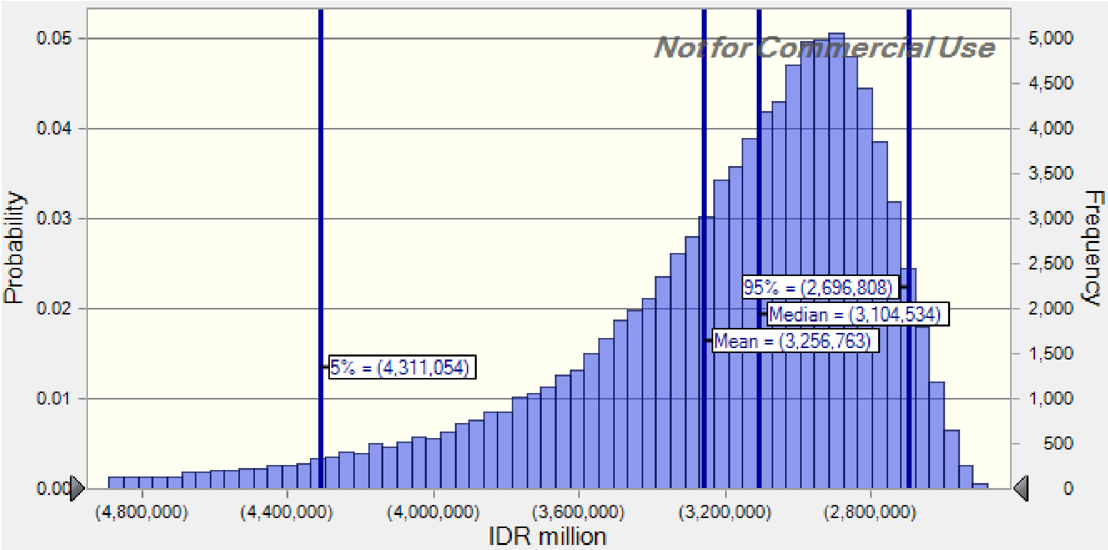
The skewness of each probability distribution for 2018 and 2019 are similar, around 3, which suggests that they have long tails on the right part leading to their maximum values. For 2018, the payment to Sarulla is likely to be around IDR 3 trillion with an average payment of IDR 3.2 trillion. There is also a 50% chance that the payment will be IDR 3.084 or more but the chance of payment over IDR 4.3 trillion is just 5%, and the chance of paying less than IDR 2.7 trillion is also 5% (see Figure 5.5).

Figure 5.5 Probability distribution of electricity payment to Sarulla geothermal project for 2018 in IDR million.



The PLN payment to Sarulla for 2019 will be quite similar to the payment for 2018, with similar mean and median values. The difference between PLN's estimated payment for 2018 and 2019 would be around IDR 30 billion.

Figure 5.6 Probability distribution of electricity payment to Sarulla geothermal project for 2019 in IDR million.



5.3.1.2 Project Revenue

After purchasing electricity from the Sarulla project, PLN sells it to its retail customers at a regulated price, but PLN cannot sell all of the electricity because there is a loss. The net electricity sales are then compared to the amount PLN has to pay the Sarulla IPP. If the net sales are more than the payment obligation, the additional electricity from the project will also add to PLN's profit. However, if it the net sales are lower than the payment obligation, PLN needs to take its operating income to pay the IPP.

The forecast net electricity sales for 2018 will be IDR 2.75 trillion as stated in the base case, mean and median values. Based on the same measures, for the following year, PLN will earn around IDR 2.87 trillion (see Table 5.5).

Table 5.5 Simulation results of net electricity sales from Sarulla geothermal project for 2018 and 2019 in IDR million.

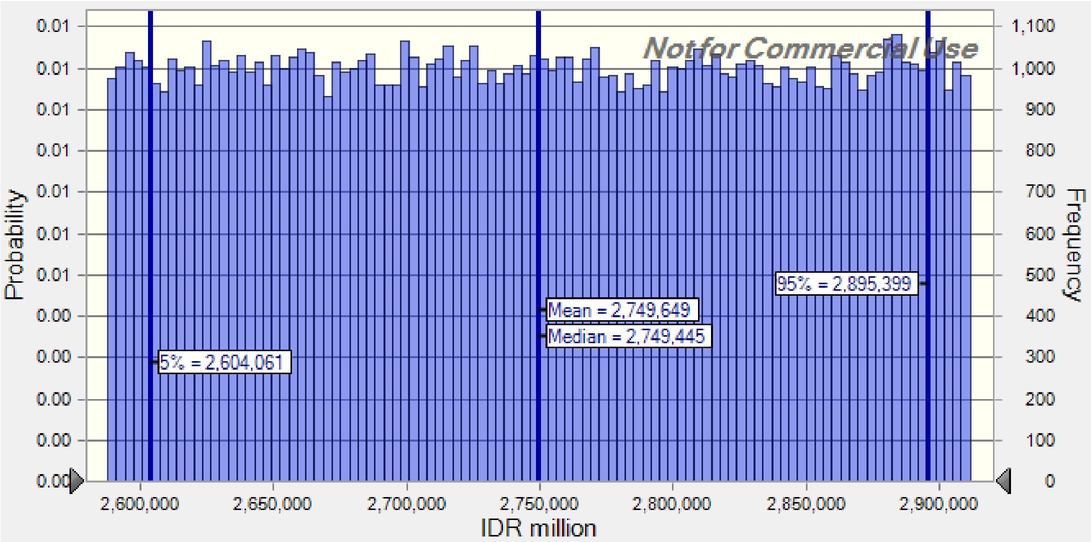
Statistics	**Forecast values**	
	2018	2019
Trials	100,000	100,000
Base Case	2,749,710	2,867,850
Mean	2,749,685	2,867,788
Median	2,749,445	2,867,575
Standard Deviation	93,424	97,438
Skewness	0.0033	0.0033
Kurtosis	1.80	1.80
Coefficient of Variation	0.0340	0.0340
Minimum	2,587,963	2,699,154
Maximum	2,911,454	3,036,544
Mean Std. Error	295	308

The similarity between the base case, median and mean values is supported by the skewness value of zero. Figure 5.7 shows that the probability distributions of the net sales for 2018 will nearly resemble a uniform distribution. A uniform distribution is a simple type of distribution which is defined by its minimum and maximum values (Hensher, Rose & Greene 2005; Kaminskiy 2012) and has a rectangular shape (see Figure 5.7). According to Charnes (2007) and Kroese, Taimre and Botev (2013), this distribution has three features: its minimum value is fixed, its maximum value is fixed, and all values between the minimum and maximum are equally likely to occur.

From the net electricity sales from the Sarulla geothermal project for 2018 and 2019 data, all of the number bins have a similar possibility of happening, around a 1% chance, so the probability of the minimum and maximum value will be similar. Another impact of this probability distribution type is that the minimum and maximum values under a 90% certainty level will only differ slightly from those numbers with a 100% certainty level.

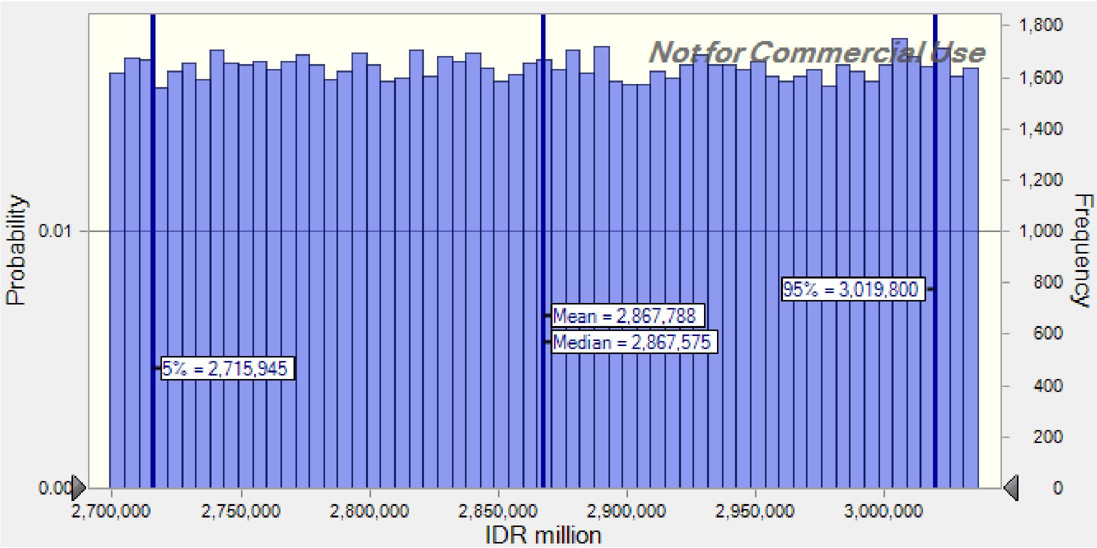
For 2018, the centre of measurement shows that PLN revenue from the Sarulla project will be around IDR 2.75 trillion. This also means that there is 50% chance that revenue will be more or less than that figure. However, the chance that the revenue will be more than IDR 3.9 trillion or less than IDR 2.6 trillion will be 5%.

Figure 5.7 Probability distribution of net electricity sales from Sarulla geothermal project for 2018 in IDR million



For the following year, it is expected that the revenue will slightly increase to be around IDR 2.9 trillion. For the year, there is a 50% chance that the revenue will be more or less than IDR 2.87 trillion with a 5% chance of making more than IDR 3 trillion.

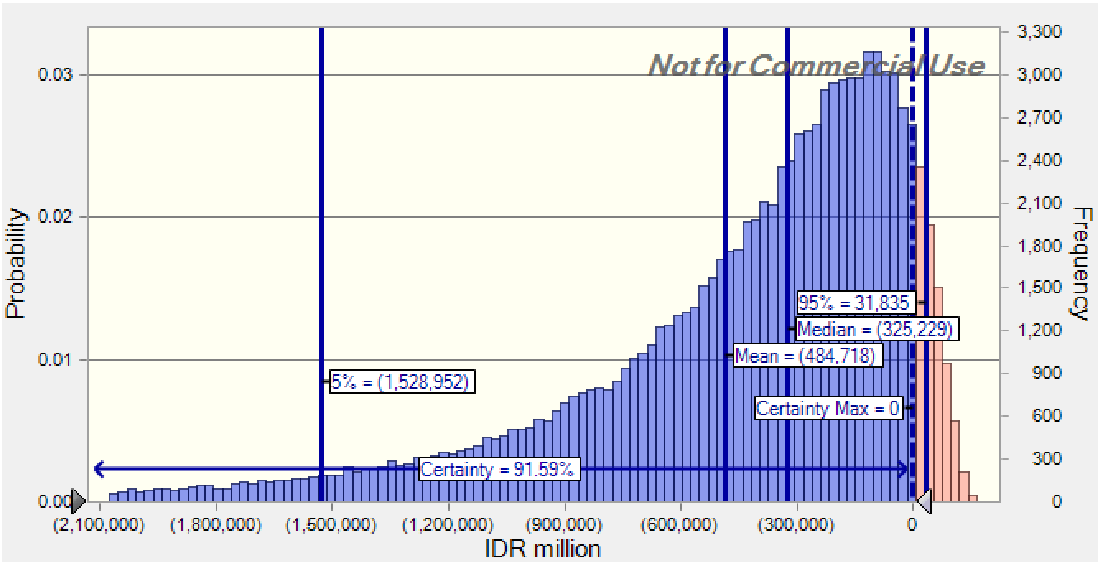
Figure 5.8 Probability distribution of net electricity sales from Sarulla geothermal project for 2019 in IDR million



5.3.1.3 Financial Impact

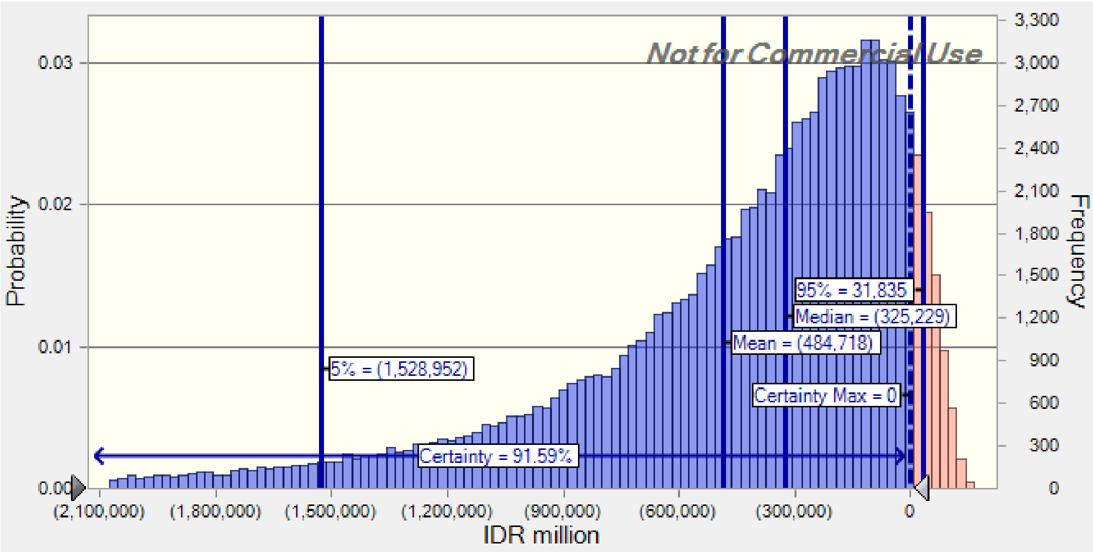
PLN will likely pay the Sarulla IPP more than PLN's earnings from the electricity sales, so PLN will suffer loss. For 2018, there will be around a 91.6% chance that PLN will suffer a deficit from the Sarulla project. Figure 5.9 shows several possible surpluses/(deficits) (risk consequence), together with their corresponding probability (risk likelihood), from the Sarulla geothermal project. The results of the 100,000 generated trials simulation are grouped into 100 bins. Each of the bins has its own probability and consequence. For 2018, the deficit for PLN from this geothermal project will be on average IDR (485) billion with a median of around IDR (325) billion. Under 90% certainty, the maximum deficit will be around IDR (1.5) trillion, and the maximum surplus will be around IDR 31.2 billion (see Figure 5.9).

Figure 5.9 Probability distribution of surplus/(deficit) from the Sarulla geothermal project for 2018 in IDR million



For 2019, PLN's probability of loss from the Sarulla project will just under 80%. It is expected with 50% probability that the loss will be less than IDR (230) billion, and with 5% probability that the loss will be more than IDR (1.4) trillion, but the average loss will be around IDR (388) billion. There is a 20% chance that PLN will get a surplus from the Sarulla project with a 5% chance that the surplus will be more than IDR 129.7 billion.

Figure 5.10 Probability distribution of surplus/(deficit) from the Sarulla geothermal project for 2019 in IDR million



5.3.2 Lahendong VI geothermal project

Another geothermal project that was tendered in 2013 is the Lahendong VI geothermal project. As this geothermal power plant is own by an IPP which is situated in North Sulawesi with 20 MW capacity, PLN will have to pay the Lahendong VI IPP based on the region II price.

5.3.2.1 Project Cost

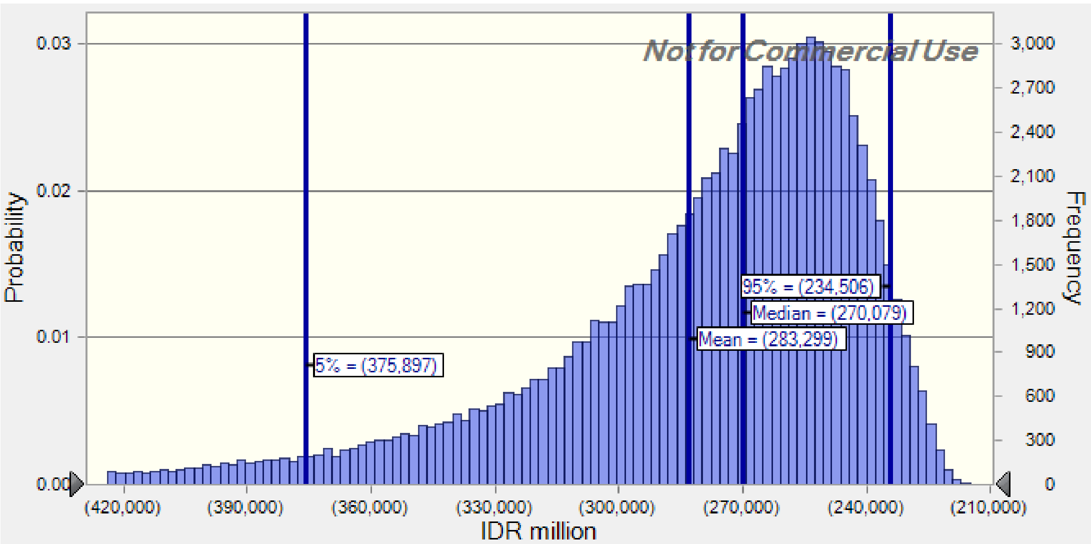
The payment of PLN to Lahendong IV IPP for 2018 and 2019, based on the deterministic simulation, will be IDR 270 billion and IDR 271 billion respectively. Meanwhile, the probabilistic simulation resulted in median values of IDR 270 billion and IDR 272 billion with the mean values of IDR 283 billion and IDR 286 billion consecutively. The forecasted electricity payment for Sarulla will be between IDR 215 billion to IDR 1,527 billion for 2018 and between IDR 217 billion to IDR 1,712 billion for 2019 (see Table 5.6).

Table 5.6 Simulation results of electricity payment to Lahendong VI geothermal project for 2018 and 2019 in IDR million

Statistics	Forecast values	
	2018	2019
Trials	100,000	100,000
Base Case	(269,490)	(271,459)
Mean	(283,710)	(285,574)
Median	(270,226)	(272,125)
Standard Deviation	51,032	51,428
Skewness	(2.99)	(3.29)
Kurtosis	22.47	30.62
Coefficient of Variation	(0.1799)	(0.1801)
Minimum	(1,526,941)	(1,712,455)
Maximum	(214,864)	(217,494)
Mean Std. Error	161	163

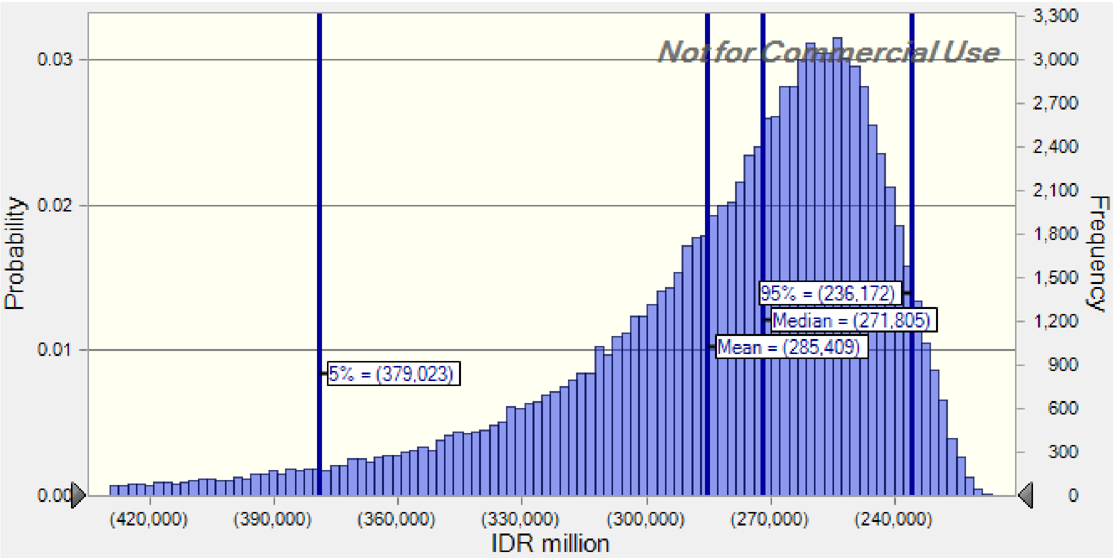
For 2019, the estimated skewness value is around -3, so there will be a long tail on the left side and a shorter tail on the right end of the probability distributions. As a result, the likelihood of the minimum and maximum values will be small, with only a 5% chance that PLN has to pay Lahendong IV IPP more than IDR 376 billion or less than IDR 235 billion. According to Figure 5.11, the payment will be around IDR 250 billion with a mean of IDR 283 billion and median of IDR 270 billion.

Figure 5.11 Probability distribution of electricity payment to Lahendong VI geothermal Project for 2018 in IDR million



For 2019, the PLN financial obligation regarding the Lahendong VI project will be around IDR 260 billion, and with a 45% chance, the payment will be around IDR 272 billion to IDR 236 billion. Payment of more than IDR 379 billion or more than IDR 236 billion will have a 5% likelihood.

Figure 5.12 Probability distribution of electricity payment to Lahendong VI geothermal Project for 2018 and 2019 in IDR million



5.3.2.2 Project Revenue

It was found that from electricity bought from the Lahendong VI project, PLN can generate more predictable revenue than their cost (purchased electricity payment to IPP), with a mean of IDR 167 billion for 2018 and IDR 174 billion for 2019, with a relatively narrow range width of around IDR 20 billion (see Table 5.7).

Table 5.7 Simulation results of net electricity sales from Lahendong VI geothermal project for 2018 and 2019 in IDR million.

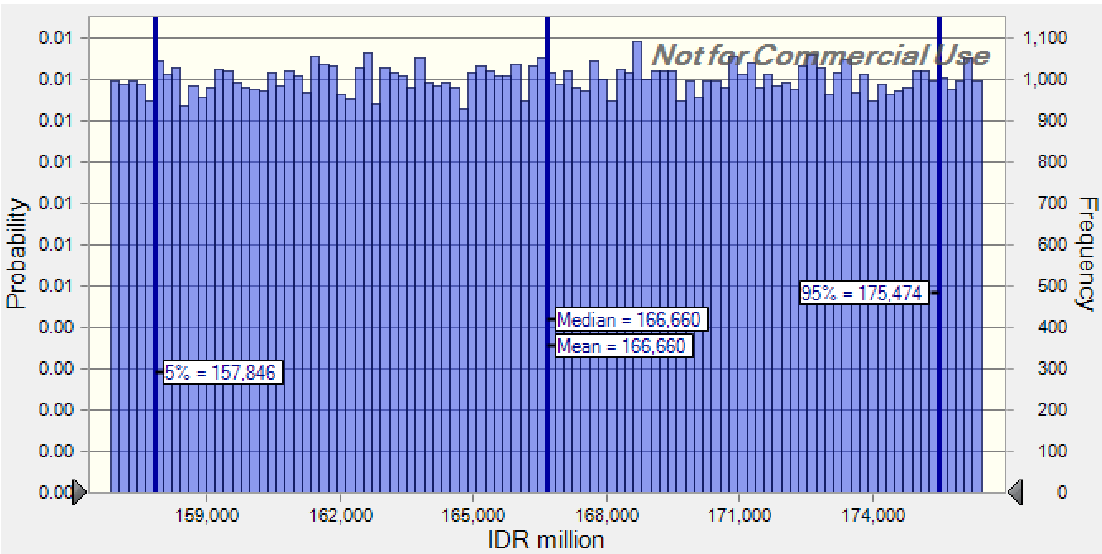
Statistics	Forecast values	
	2018	2019
Trials	100,000	100,000
Base Case	166,649	173,809
Mean	166,660	173,820
Median	166,660	173,820
Standard Deviation	5,655	5,898
Kurtosis	1.80	1.80
Coefficient of Variation	0.0339	0.0339
Minimum	156,847	163,586
Maximum	176,452	184,033
Mean Std. Error	18	19

The already narrow range width becomes narrower under 90% certainty level, so the net electricity sales from the Lahendong VI project turn out to be more predictable. Based on this certainty level, the net sales will be between IDR 158 billion to IDR 175 billion for 2018 and between IDR 165 billion to IDR 183 billion for 2019 (see Figure 4.13 and Figure 5.14).

5.3.2.3 Financial Impact

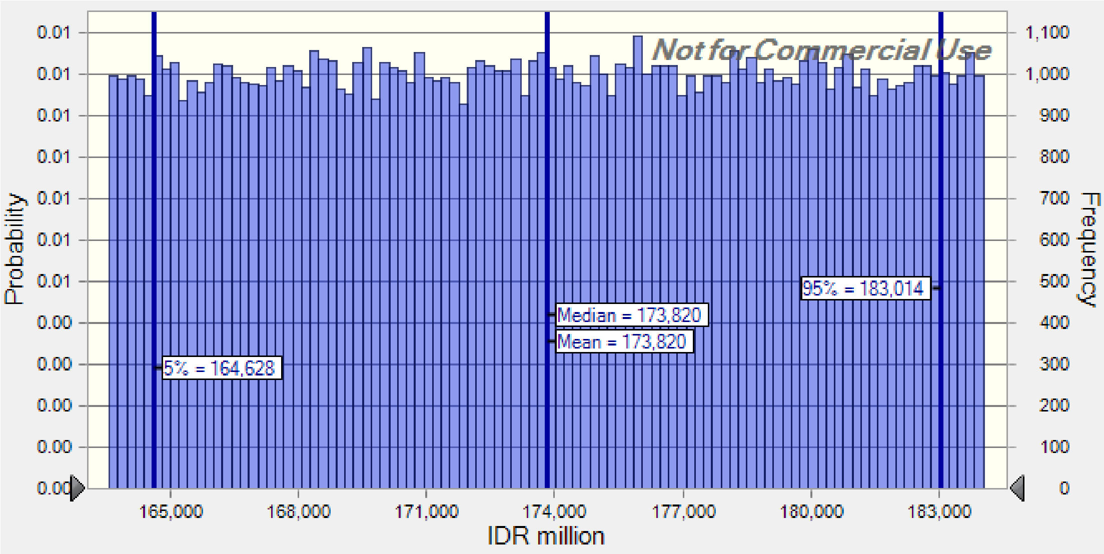
Based on the centre of measurement, PLN income from the Lahendong project will be around IDR 166 billion for 2018. There is a 5% chance that PLN will receive more than IDR 175 billion or less than IDR 158 billion.

Figure 5.13 Probability distribution of net electricity sales from Lahendong VI geothermal project for 2018 in IDR million



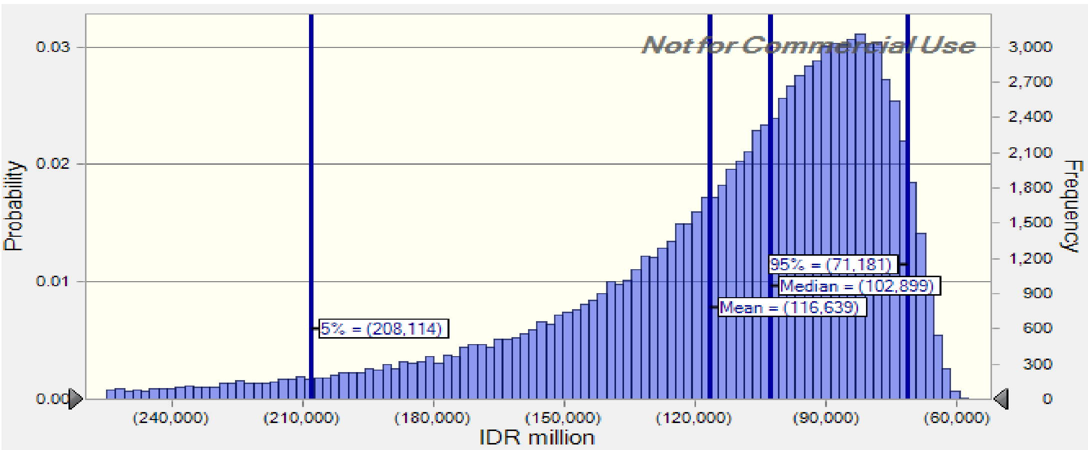
Meanwhile, for 2019, PLN will likely be receiving around IDR 178 billion from selling Lahendong electricity. There is a 5% chance that PLN will receive income of up to IDR 165 billion or more than IDR 183 billion.

Figure 5.14 Probability distribution of net electricity sales from Lahendong VI geothermal project for 2019 in IDR million



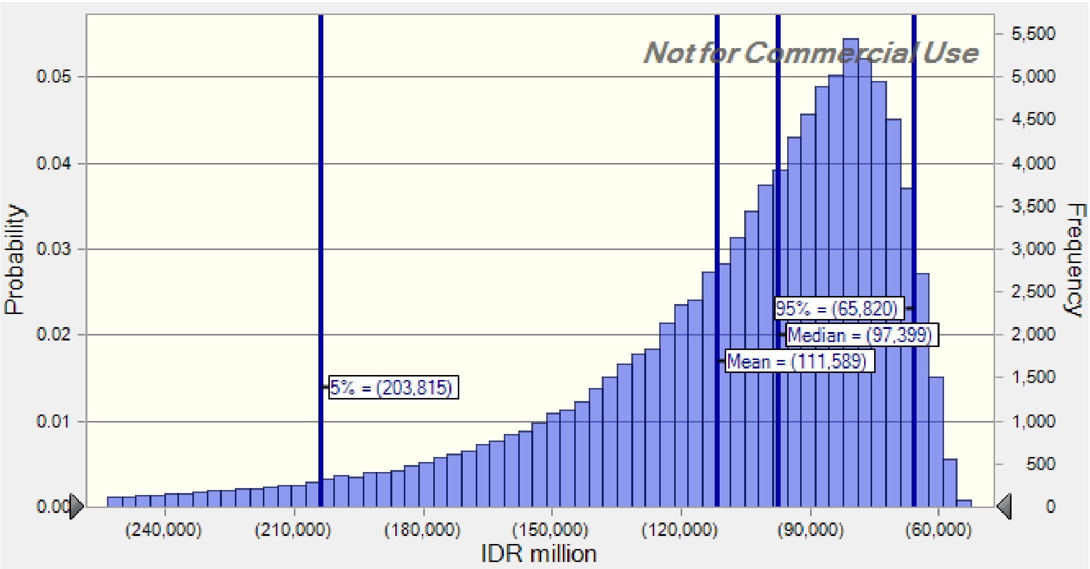
This Lahedong VI geothermal project will commence and operate in 2018. For the first two years, it is likely that PLN will pay more for electricity to the IPP than PLN revenue from retailing the electricity. Figure 5.15 shows that there is around a 100% chance that PLN will suffer a deficit from this Lahendong project for 2018, with a likely deficit of around IDR (80) billion. There is a 45% chance that deficit will be around IDR (103) billion to IDR (71) billion (see Figure 5.15).

Figure 5.15 Probability distribution of deficit from the Lahendong VI geothermal project for 2018 in IDR million



The 100% probability of suffering loss was also found in the second-year operation of the Sarulla Project. There is a 50% chance that the loss will be around IDR (97) billion or less but there is also a 5% chance that the loss will exceed IDR (204) billion and a 5% chance that the loss will be less than IDR (66) billion. Meanwhile, the average loss will be around IDR (112) trillion for 2019 (see Figure 5.16).

Figure 5.16 Probability distribution of deficit from the Lahendong VI geothermal project for 2019 in IDR million



5.3.3 Lumut Balai Geothermal Project

Lumut Balai is the second largest geothermal project with 220 MW and is expected to start commercially operating in 2019. It is an IPP project which is located on Sumatera Island so the IPP will receive an electricity payment from PLN that follows the regulated region I geothermal electricity price.

5.3.3.1 Project Cost

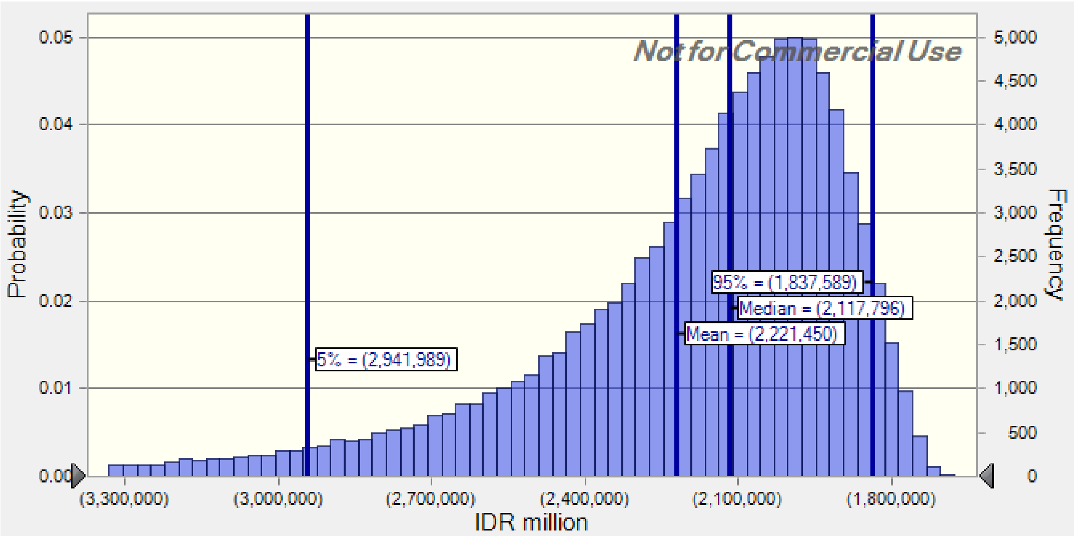
This project will be likely to make PLN purchase electricity from the Lumut Balai IPP for more than IDR 2 trillion for 2019. The result of the base case will be IDR 2.1 trillion, similar to the median values after 100,000 trials of a Monte Carlo Simulation. The mean value will be only around IDR 100 billion more than the base case and the median value. However, the possible amount of this PLN payment obligation to the Lumut Balai IPP will vary between IDR 1.7 trillion to IDR 10.5 trillion (see Table 5.8).

Table 5.8 Simulation results of electricity payment to Lumut Balai geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(2,112,914)
Mean	(2,221,450)
Median	(2,117,796)
Standard Deviation	402,382
Skewness	(3.08)
Kurtosis	21.66
Coefficient of Variation	(0.1810)
Minimum	(8,910,444)
Maximum	(1,685,855)
Mean Std. Error	1,272

The probability of the maximum value will be small as the skewness value will be around 3 which means the probability distribution of the payment will be right skewed with a long tail through the highest number (see Figure 5.17).

Figure 5.17 Probability distribution of electricity payment to Lumut Balai geothermal Project for 2019 in IDR million.



5.3.3.2 Project Revenue

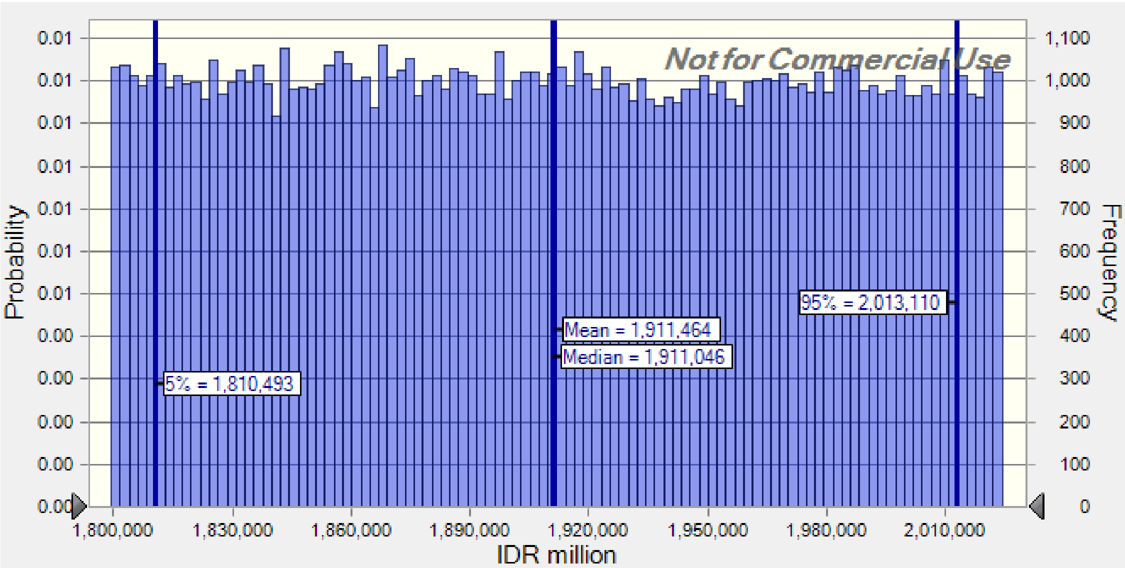
After simulating PLN financial conditions regarding this Lumut Balai project for 2019, it was found that PLN will be likely to receive electricity payments from its customers less than PLN has to pay the Lumut Balai IPP. The net electricity revenue from this project will be around IDR 1.9 trillion with a probability value of around IDR 1.8 to 2 trillion (see Table 5.9).

Table 5.9 Simulation results of net electricity sales from Lumut Balai geothermal project for 2019 in IDR million.

Statistics	Forecast values
Trials	100,000
Base Case	1,911,900
Mean	1,911,464
Median	1,912,046
Standard Deviation	64,786
Skewness	0.0024
Kurtosis	1.80
Coefficient of Variation	0.0339
Minimum	1,799,438
Maximum	2,024,365
Mean Std. Error	205

Focusing on the 90% certainty, for the net sales, the lowest value for 2019 will be IDR 1.8 trillion, and the highest value will be IDR 2 trillion. As the probability distribution almost replicates a uniform distribution, all values will have a similar chance to happen which is around 1% probability (see Figure 5.18).

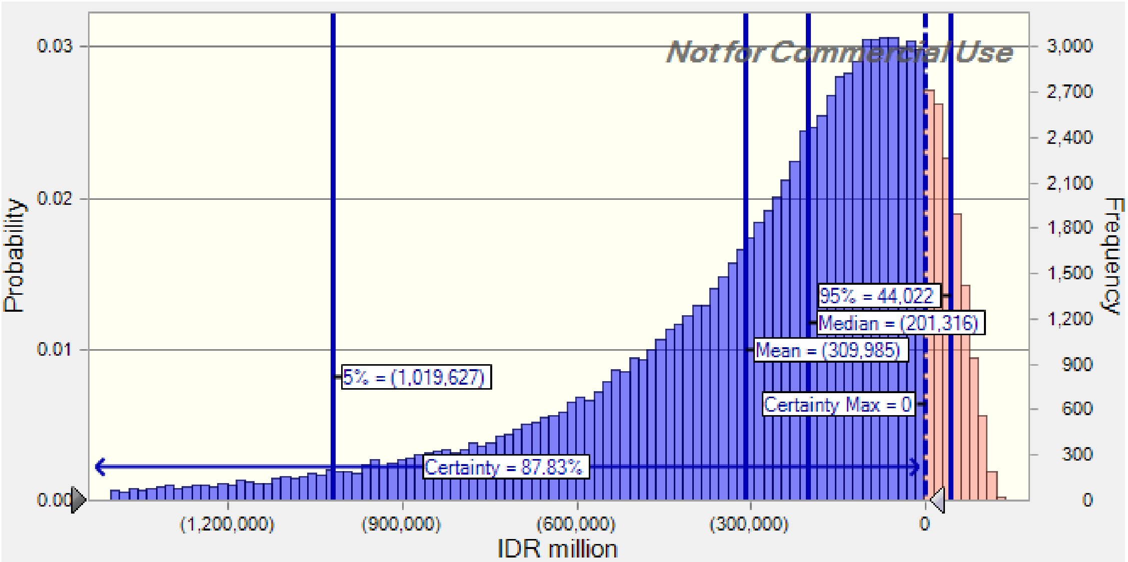
Figure 5.18 Probability distribution of net electricity sales from Lumut Balai geothermal project for 2019 in IDR million



5.3.3.3 Financial Impact

For PLN, in the first operation year, this project will likely to have a deficit, with just under 90% probability. There is a 50% chance that the loss will be up to around IDR (202) billion and a 5% chance that the loss will be more than IDR (1) trillion. On the positive side, there is just over a 10% chance that this project will give PLN a surplus with a 5% chance that the surplus will be more than IDR 43 billion (see Figure 5.199).

Figure 5.19 Probability distribution of surplus/(deficit) from the Lumut Balai geothermal project for 2019 in IDR million



5.3.4 Tulehu Geothermal Project

The eastern part of Indonesia has a low electrification ratio, so to reduce the electrification ratio gap with other regions of Indonesia the government decided to build more power plants in that region, including the Tulehu geothermal project. The geothermal developer is an IPP. It is located in Maluku province, so PLN has to pay the IPP based on the region III electricity price.

5.3.4.1 Project Cost

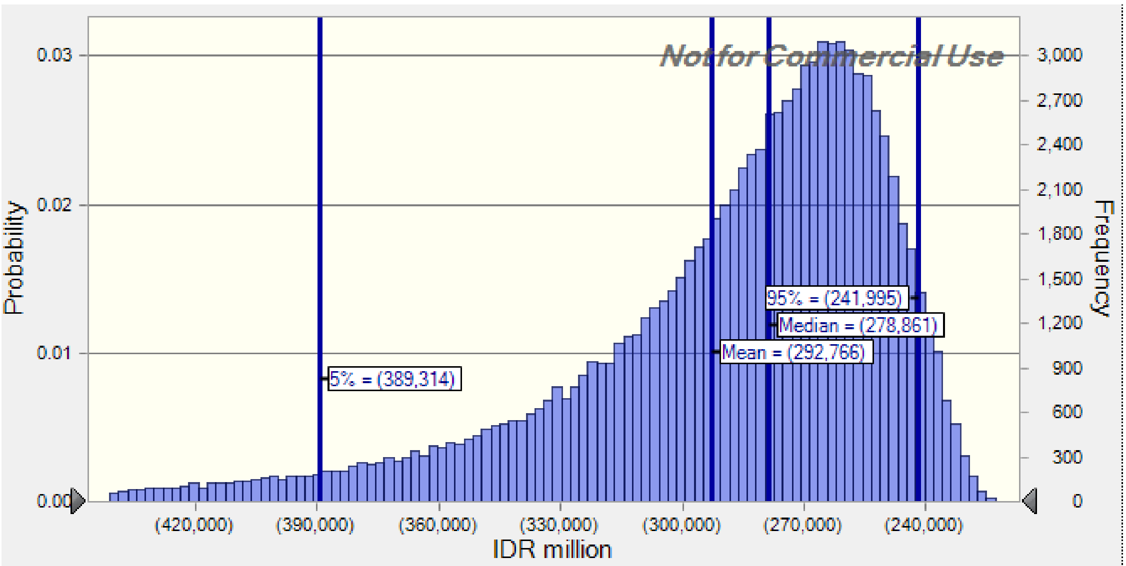
For PLN, this project seems not to be profitable because for this region, PLN has to pay the highest price, but cannot set a higher electricity price. This additional power plant cost will make PLN pay IDR 293 billion (mean value) for 2019 with a risk of a lesser or greater payment in an interval of between IDR 221 to 1,704 billion. The base case and the median value of the electricity purchased payment to the Tulehu IPP will be quite similar to the mean value (see Table 5.10).

Table 5.10 Simulation results of electricity payment to Tulehu geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(278,090)
Mean	(292,766)
Median	(278,861)
Standard Deviation	52,601
Skewness	(3.06)
Kurtosis	23.23
Coefficient of Variation	(0.1797)
Minimum	(1,398,221)
Maximum	(221,890)
Mean Std. Error	166

However, the probability for PLN to pay the high amount nearest the minimum amount will be little since it lies on the distribution tail. The probability distribution of the electricity payment has a long tail since it has a positive skewness value of -3.06 and as a result there is only a 5% chance that the payment will be more than IDR 389 billion. The probability distribution graph peaks at around IDR (255) billion, so the likeliest value of PLN's electricity payment to Tulehu for 2019 will be around IDR 255 billion with an average value of IDR 292.8 billion (see Figure 5.20).

Figure 5.20 Probability distribution of electricity payment to Tulehu geothermal project for 2019 in IDR million



5.3.4.2 Project Revenue

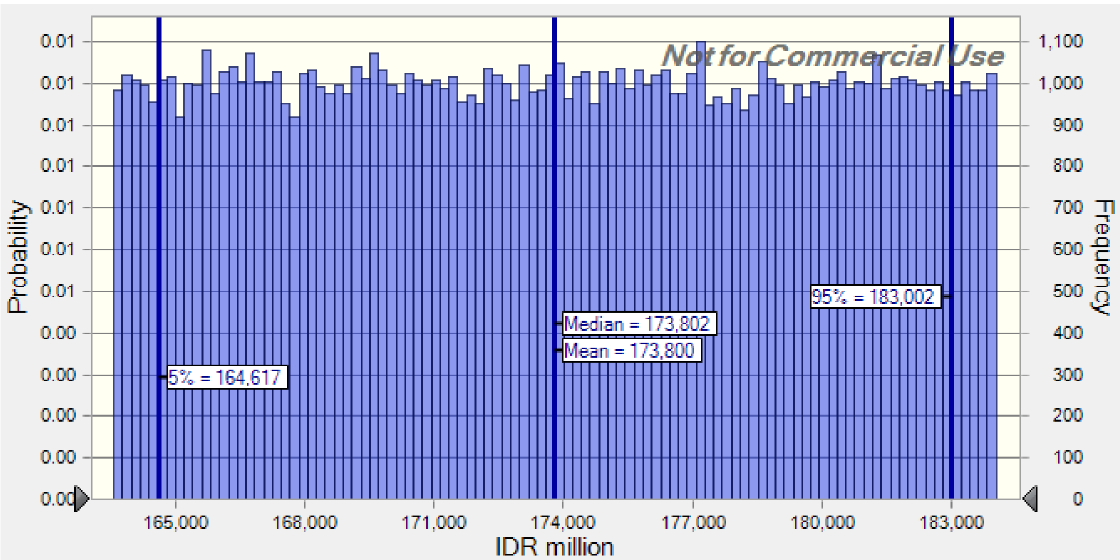
The Monte Carlo simulation results indicate that the net sales of the electricity from the Tulehu IPP for 2019 will be around IDR 174 billion. This figure is consistent with all of the centre measurements of the results' with an interval of between IDR 164 to 184 billion (see Table 5.11).

Table 5.11 Simulation results of net electricity sales from Tulehu geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	173,809
Mean	173,800
Median	173,802
Standard Deviation	5,902
Skewness	(0.0022)
Kurtosis	1.80
Coefficient of Variation	0.0340
Minimum	163,585
Maximum	184,033
Mean Std. Error	19

Similar to probability distributions of others' net electricity sales from geothermal power plants, the Tulehu plant's also nearly resembles a uniform probability distribution. Therefore, it also has similar features of distribution (see Figure 5.21).

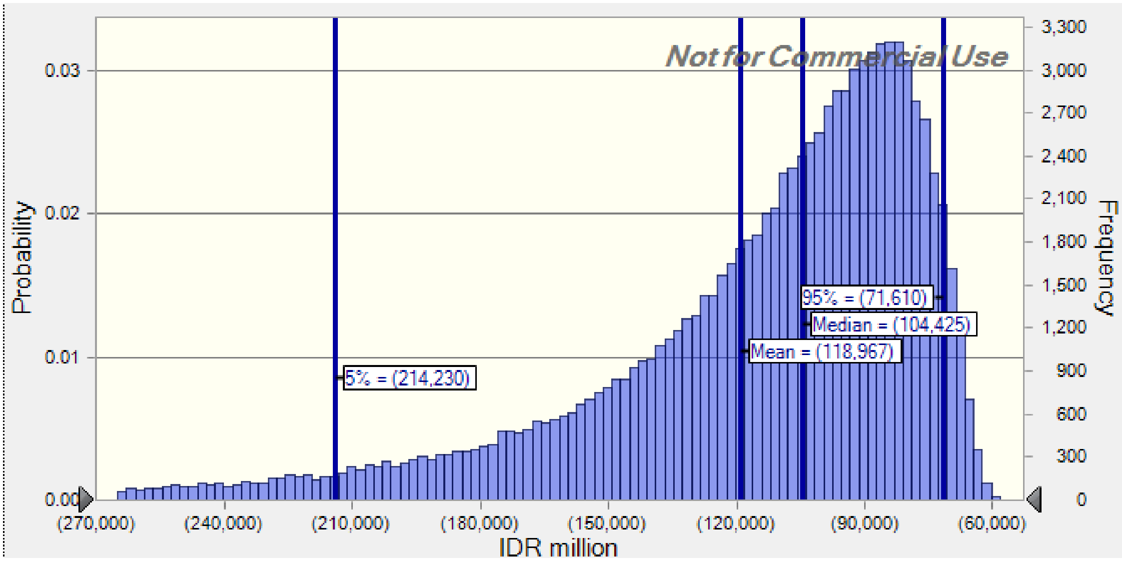
Figure 5.21 Probability distribution of net electricity sales from Tulehu geothermal project for 2019 in IDR million



5.3.4.3 Financial Impact

For 2019, PLN is likely to pay the Tulehu IPP more than its revenue from retailing Tulehu's electricity as there is 0% chance that this project generates profit for PLN. Instead of making a profit, this project will give PLN a deficit of around IDR (90) billion (the highest probability or mode) for 2019. There is a 50% chance that the loss will be up to IDR (104) trillion and a 5% chance that the loss will be up to IDR (72) billion but there is also a 5% chance that the loss will be more than IDR (214) billion for 2019 (see Figure 5.22).

Figure 5.22 Probability distribution of deficit from the Tulehu geothermal project for 2018 and 2019 in IDR million



5.3.5 Patuha Geothermal Project

The Patuha geothermal project is located in West Java, an extension of the previous geothermal power plant, so it is eligible for region 1 geothermal price. The developer of this 55 MW capacity geothermal power plant is an IPP, and the expected COD is in 2019.

5.3.5.1 Project Cost

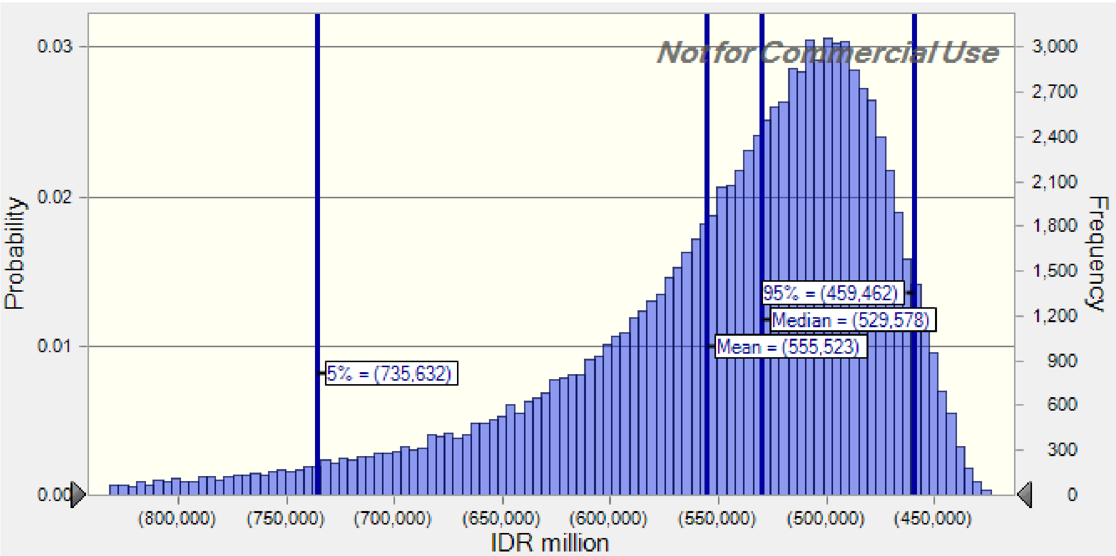
After running a 100,000 trials simulation, it was found that in the base case, PLN has to purchase the electricity for IDR 528 billion, which is only slightly different from the median value of IDR 529 billion. The mean value, however, shows a more significant figure of around IDR 25 billion. The PLN payment to Patuha IPP for 2009 will be around IDR 420 billion to IDR 2.6 trillion (Table 5.12).

Table 5.12 Simulation results of electricity payment to Patuha, geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(528,228)
Mean	(555,523)
Median	(529,578)
Standard Deviation	99,349
Skewness	(3.00)
Kurtosis	21.63
Coefficient of Variation	(0.1788)
Minimum	(2,566,186)
Maximum	(420,643)
Mean Std. Error	314

The PLN payment to the Patuha developer will be stochastic with a 50% chance of payment of less than IDR 529 billion. The payment will be likely around IDR 500 billion with a 5% chance of payment between IDR 459 billion to IDR 420 billion (see Figure 5.23).

Figure 5.23 Probability distribution of electricity payment to Patuha geothermal project for 2019 in IDR million



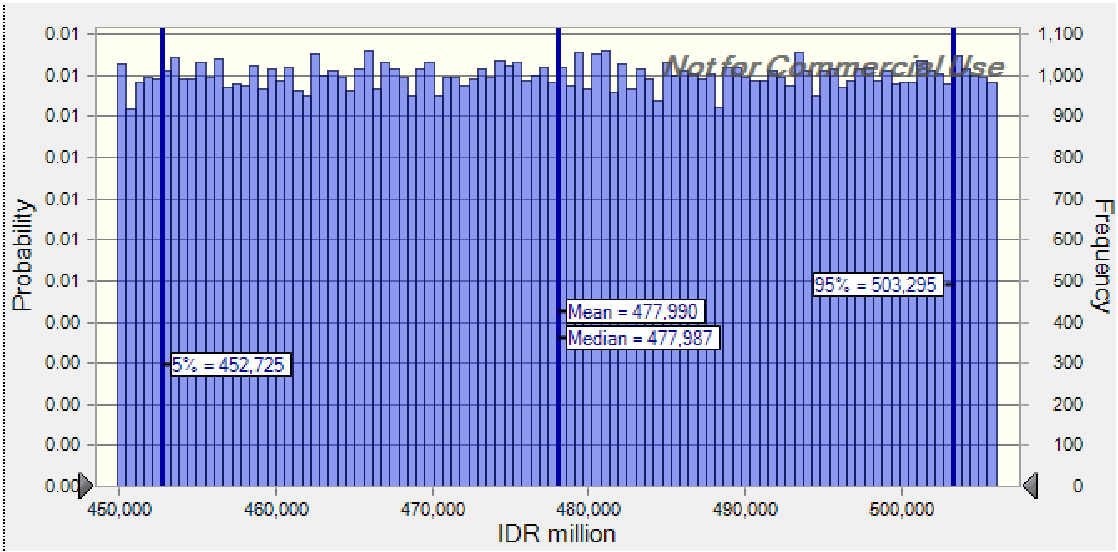
Regarding the net electricity sales from the Patuha power, PLN can earn around IDR 478 billion for 2019. The minimum value will be IDR 450 billion and the maximum value of IDR 506 billion (see Table 5.13).

Table 5.13 Simulation results of net electricity sales from Patuha geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	477,975
Mean	477,990
Median	477,987
Standard Deviation	16,225
Skewness	0.0019
Kurtosis	1.80
Coefficient of Variation	0.0339
Minimum	449,859
Maximum	506,091
Mean Std. Error	51

Meanwhile, under 90% certainty, the minimal net sales will be IDR 453 million and the maximum value IDR 503 billion for 2019. As it is uniformly distributed, the mean and median values will be the same and variation of the result will be low (see Figure 5.24).

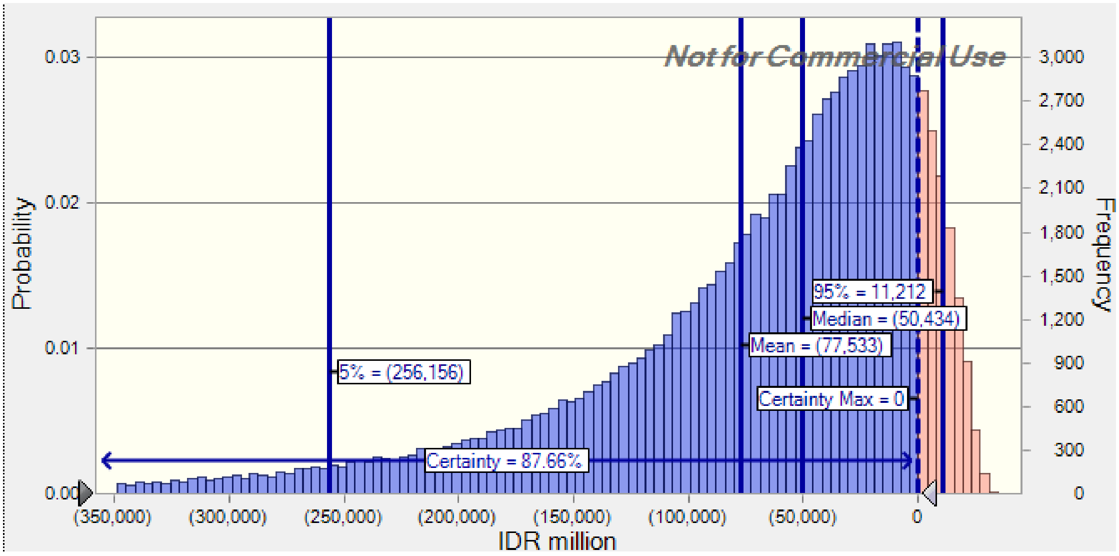
Figure 5.24 Probability distribution of net electricity sales from Patuha geothermal project for 2019 in IDR million



5.3.5.2 Financial Impact

PLN's business of purchasing electricity from the Patuha project then reselling it to its retail customers will be less likely able to make a profit with a probability of around 12%. As the probability distribution graph of the surplus/(deficit) has a long-left tail, the maximum loss will have only a slight chance, less than 0.5% but there is a 5% chance that the deficit will be more than IDR (256) billion. With average loss of IDR (77) billion, there is a 5% chance that PLN might have a surplus of more than IDR (11) billion (see Figure 5.25).

Figure 5.25 Probability distribution of surplus/(deficit) from the Patuha, geothermal project for 2019 in IDR million



5.3.6 Tangkuban Perahu 1 Geothermal Project

Another geothermal power plant located in West Java is Tangkuban Perahu. It also has a similar capacity to Patuha, 55 MW, so the financial characteristics of the two projects will be similar.

5.3.6.1 Project Cost

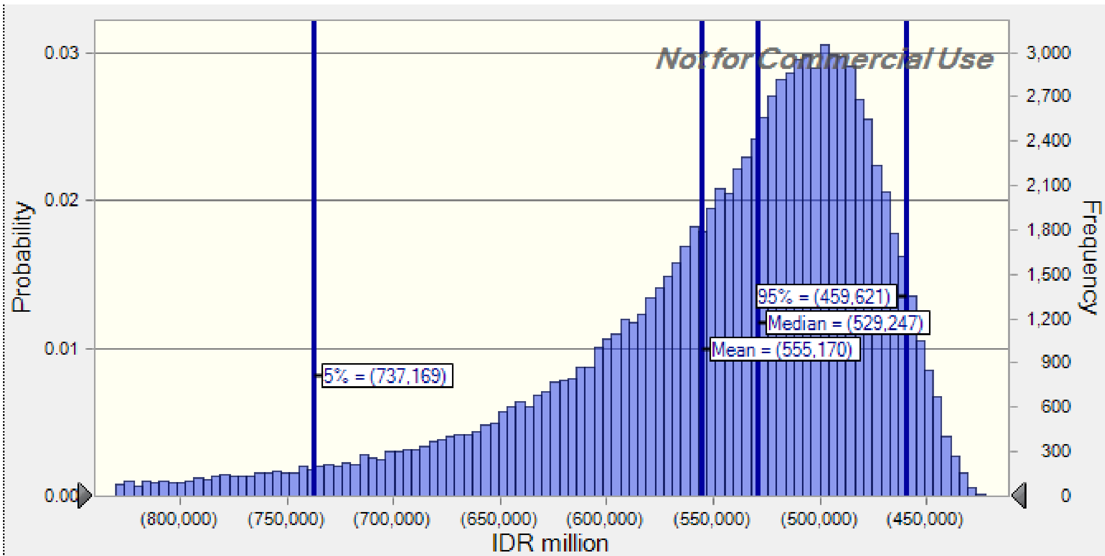
It is likely that PLN will have to pay around IDR 500 MW to the IPP for purchasing electricity in 2019. However, this amount is not certain; it can change to any amount from IDR 421 billion to IDR 2.3 trillion (see Table 5.14).

Table 5.14 Simulation results of electricity payment to Tangkuban Perahu 1 geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(528,228)
Mean	(555,170)
Median	(529,247)
Standard Deviation	98,995
Skewness	(2.97)
Kurtosis	21.24
Coefficient of Variation	(0.1782)
Minimum	(2,338,059)
Maximum	(421,003)
Mean Std. Error	313

There is a 50% chance that PLN has to pay the IPP more than IDR 529 billion with a 5% chance it will grow to over IDR 737 billion. There is also a 5% chance that the payment will be less than IDR 460 billion.

Figure 5.26 Probability distribution of electricity payment to Tangkuban Perahu 1 Geothermal Project for 2019 in IDR million



5.3.6.2 Project Revenue

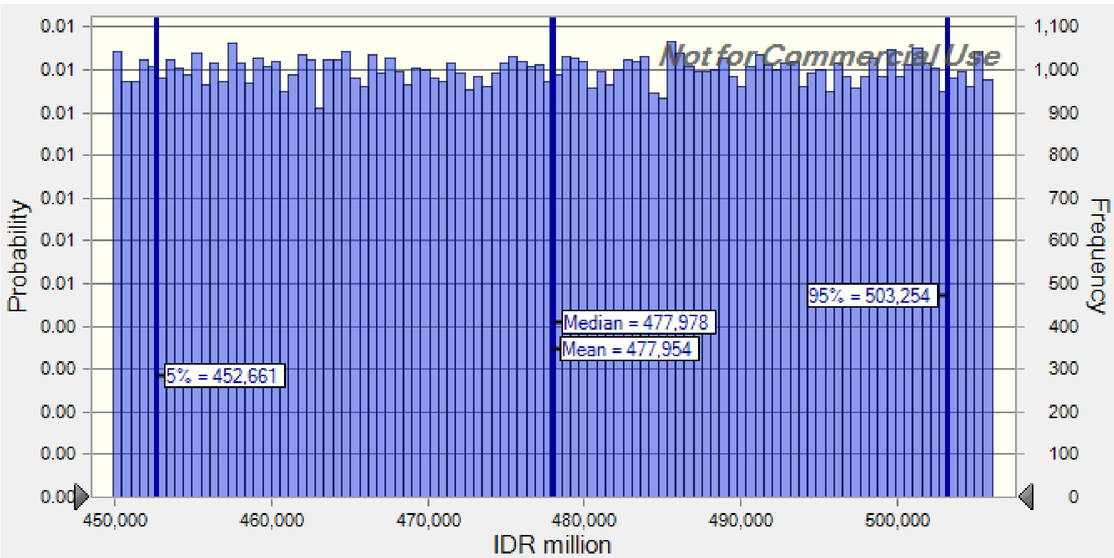
Regarding the net electricity sales from the Tangkuban Perahu 1 project, the mean and median value is lower than PLN's payment obligation to Tangkuban Perahu IPP. The variability of sales of electricity from this power plant is very low, which indicates a similar chance of any value between IDR 450 billion to IDR 506 billion occurring.

Table 5.15 Simulation results of net electricity sales from Tangkuban Perahu 1 geothermal project for 2019 in IDR million.

Statistics	Forecast values
Trials	100,000
Base Case	477,975
Mean	478,043
Median	478,063
Standard Deviation	16,216
Skewness	(0.0063)
Kurtosis	1.80
Coefficient of Variation	0.0339
Minimum	449,860
Maximum	506,090
Mean Std. Error	51

The low variability of PLN's payment obligation to Tangkuban Perahu is because of the take or pay contract between PLN and the IPPs. The most uncertain condition of this contract is the foreign exchange rate. Therefore, the uneven pattern in the probability distribution graph (see Figure 4.29) might occur because of this factor.

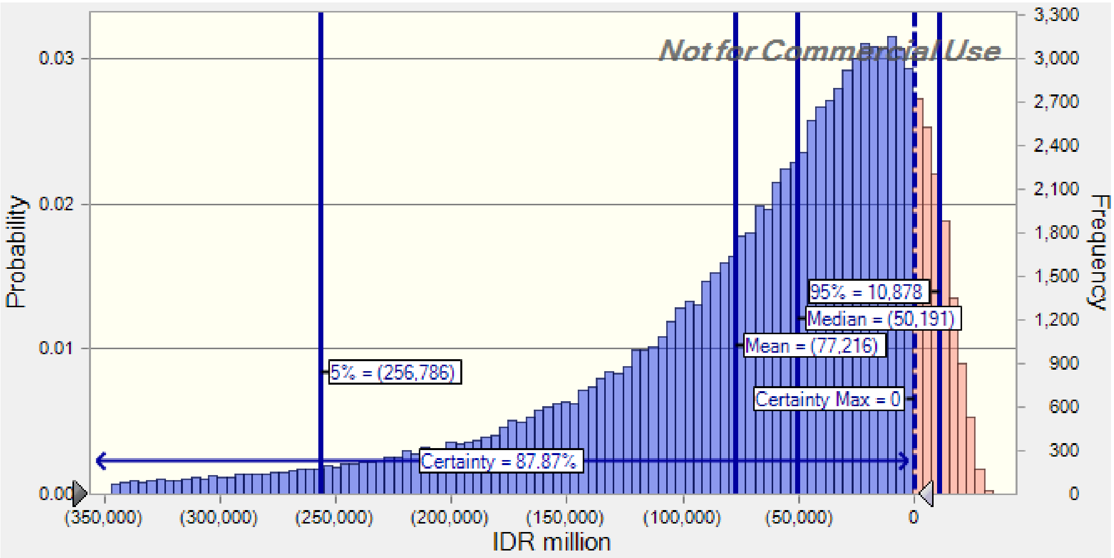
Figure 5.27 Probability distribution of net electricity sales from Tangkuban Perahu 1 geothermal project for 2019 in IDR million



5.3.6.3 Financial Impact

For 2019, the Tangkuban Perahu 1 project will have a similar condition to the Patuha project as it has similar costs and revenue and is also located in the same region, The chance of PLN getting surplus for this project is only around 12% (see Figure 5.28).

Figure 5.28 Probability distribution of surplus/(deficit) from the Tangkuban Perahu 1 geothermal project for 2019 in IDR million



5.3.7 Dieng 1 Geothermal Project

The Dieng 1 geothermal project is located in region 1, Central Java. It has a similar capacity to the Patuha and Tangkuban Perahu 1 projects, 55 MW. This project is also planned to be operational in 2019. This similarity of region and size means the Dieng project will have a similar financial impact to the Patuha and Tangkuban Perahu projects.

5.3.7.1 Project Cost

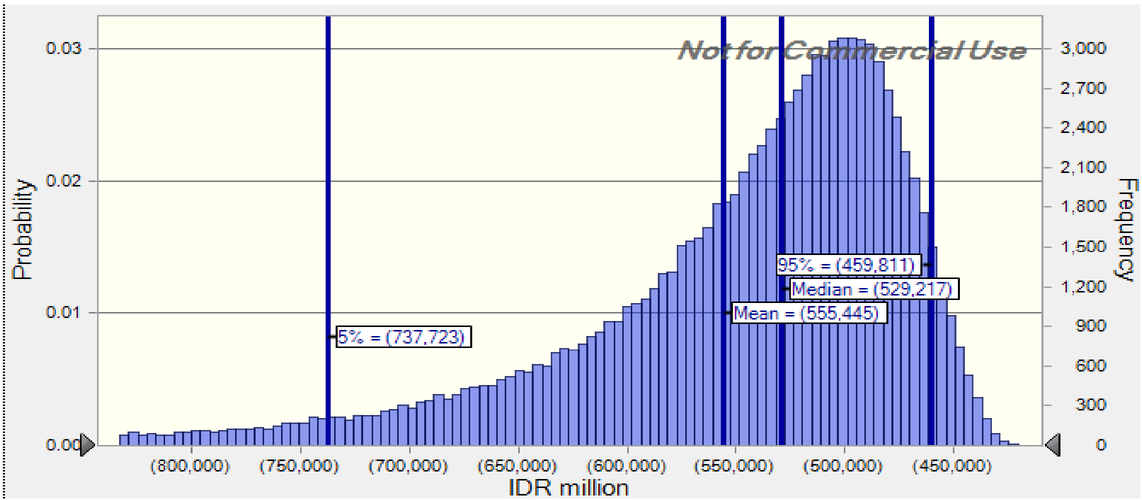
Like the Patuha and Tangkuban Perahu 1 projects, this project will be likely to make PLN purchase around IDR 500 billion, but this is not certain as the maximum payment will be IDR 2.9 trillion and the minimum payment is IDR 422 billion. In the base case scenario, the purchasing cost for PLN will be around IDR 528 billion.

Table 5.16 Simulation results of electricity payment to Dieng 1 geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(528,228)
Mean	(555,445)
Median	(529,217)
Standard Deviation	99,138
Skewness	(3.00)
Kurtosis	22.27
Coefficient of Variation	(0.1784)
Minimum	(2,877,781)
Maximum	(422,575)
Mean Std. Error	314

However, the maximum and minimum values have a low possibility of occurring because 90% chance, the payment will be between IDR 460 billion to 738 billion. The chance of mean and median value happening will be more significant.

Figure 5.29 Probability distribution of electricity payment to Dieng 1 geothermal project for 2019 in IDR million



5.3.7.2 Project Revenue

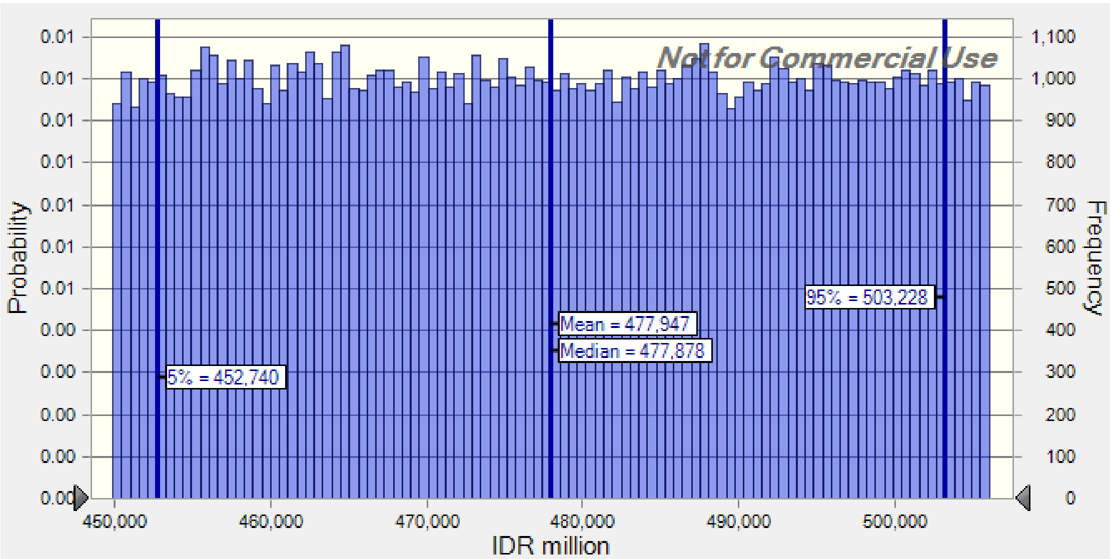
After buying electricity from Dieng IPP, PLN sells the electricity to its customers with a lower price, so it is like that the PLN revenue from this power plant will be lower than the purchasing cost. For 2019, the PLN revenue will be around IDR 478 billion, lower than the cost of around IDR 500 billion.

Table 5.17 Simulation results of net electricity sales from Dieng 1 geothermal project for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	477,975
Mean	477,947
Median	477,878
Standard Deviation	16,239
Skewness	0.0032
Kurtosis	1.80
Coefficient of Variation	0.0340
Minimum	449,859
Maximum	506,091
Mean Std. Error	51

This revenue is uniformly distributed so that the mean and median will precisely locate at the centre of the probability distribution graph. As a result, the base case, median, and mean value will be similar, and for 2019, it is likely the revenue can be any number between the minimum and maximum values.

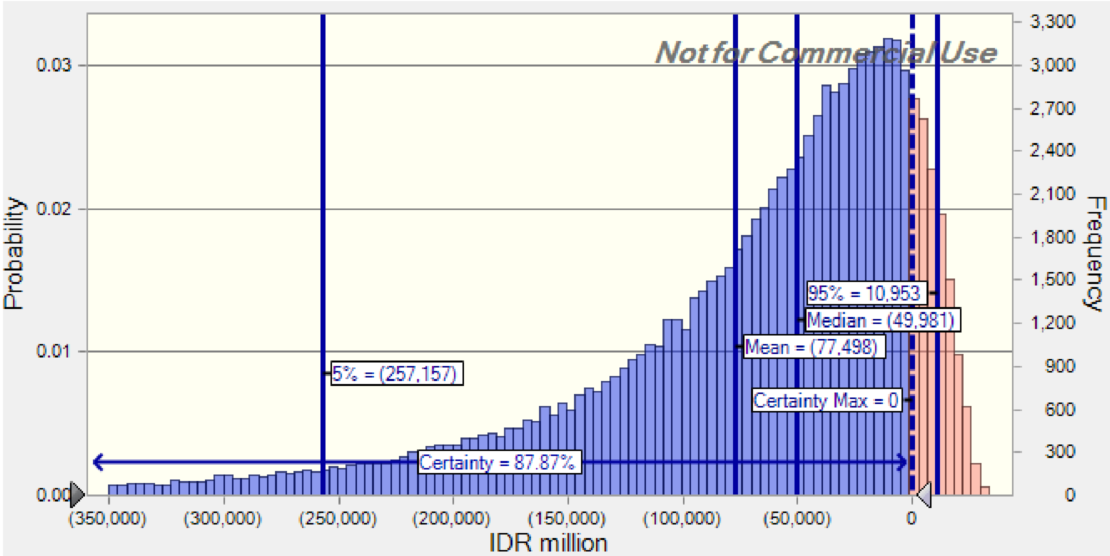
Figure 5.30 Probability distribution of net electricity sales from Dieng 1 geothermal project for 2019 in IDR million



5.3.7.3 Financial Impact

The Dieng geothermal project will be likely, with 89% probability, to make PLN suffer a loss with an average number of IDR (78) billion. It also has a 5% chance of having a surplus of more than IDR (01.8) trillion (see Figure 5.31).

Figure 5.31 Probability distribution of surplus/(deficit) from the Dieng 1 geothermal project for 2019 in IDR million



5.4 Simulation Results

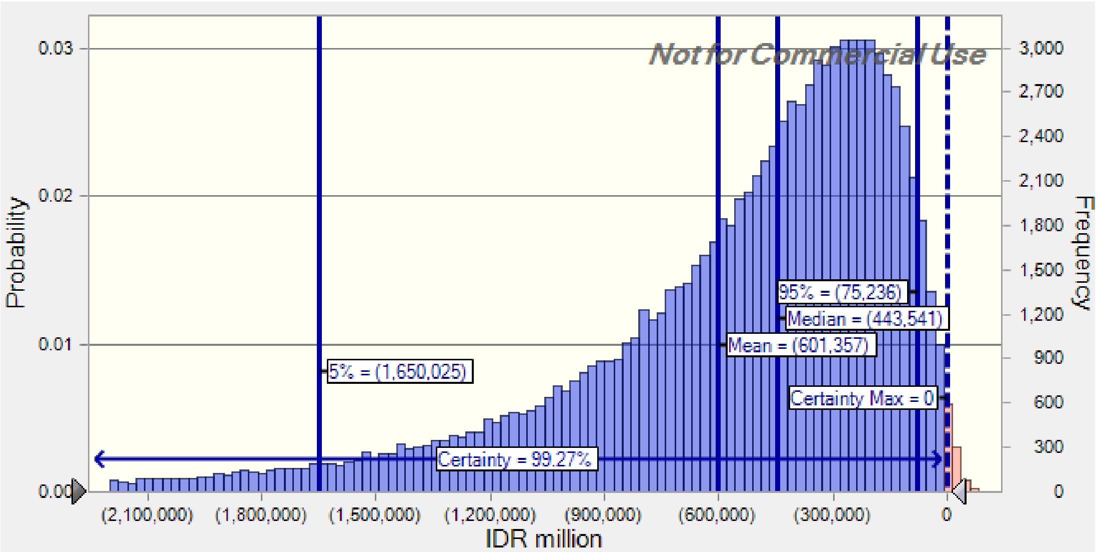
For 2018, PLN will suffer a deficit from purchasing electricity from geothermal IPPs with an average deficit of IDR (2.4) trillion. The deficit will be around IDR (19.7) trillion to IDR (907) billion. For the following year, the average deficit value will be around IDR (2.9) trillion with a possible range of between IDR (20.3) trillion to IDR (939) billion (see Table 5.18).

Table 5.18 Descriptive statistic of potential business viability exposure 2018 and 2019

Statistics	Forecast values	
	2018	2019
Trials	100,000	100,000
Base Case	(427,893)	(783,091)
Mean	(601,357)	(1,161,763)
Median	(443,541)	(1,006,283)
Standard Deviation	1,003,181	566,652
Skewness	(2.98)	(2.08)
Kurtosis	19.86	11.76
Coefficient of Variation	(0.4161)	(0.9447)
Minimum	(8,992,265)	(10,270,511)
Maximum	93,682	93,682
Mean Std. Error	3,172	(427,893)

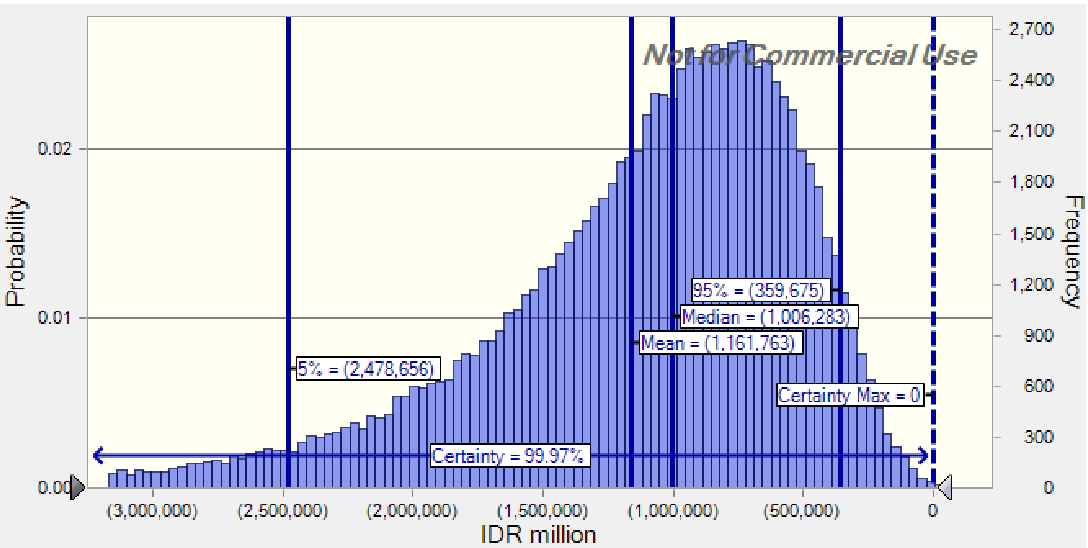
There is 0% chance that PLN is able to make a surplus and 50% chance of getting a loss of more than IDR (2.2) trillion. There is a 5% chance that the loss will be deeper than IDR (4.3) trillion and a 5% chance that the loss will be less than IDR (1.3) trillion.

Figure 5.32 Probability distribution of surplus/(deficit) from purchasing geothermal IPPs' electricity for 2018 in IDR million



For 2019, the average possible loss for PLN from purchasing electricity from geothermal IPPs will be higher. There will be more loss in this year compared to the previous year as there is a 50% chance that PLN will suffer the loss of more than IDR (2.7) trillion.

Figure 5.33 Probability distribution of surplus/(deficit) from the purchasing of geothermal IPPs' electricity for 2019 in IDR million



For 2018 and 2019, PLN will likely suffer losses so that it will not have the funds to tackle electricity payment to IPPs and to service projects' debts. The maximum deficits of PLN for 2018 and 2019 are projected to be IDR (9.0) trillion and IDR (10.2) trillion consecutively. Under a 90% certainty level, the projected minimum deficit will be much lower at IDR (1.7) trillion and IDR (2.5) trillion for those years.

Table 5.19 Surplus/(deficit) from the purchasing geothermal IPPs electricity for 2018 and 2019 in IDR million

Year	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
2018	(601,357)	(443,541)	(8,992,265)	93,682	(1,650,025)	(75,236)
2019	(1,161,763)	(1,006,283)	(10,270,511)	93,682	(2,478,656)	(1,006,283)

5.5 Chapter Summary

This chapter ran the second simulation model which is the Business Viability Simulation model. The model and its variables were explained and applied to geothermal projects which will be commercially operated in 2018 and 2019. Cost of purchasing electricity and revenue from selling electricity for each of the projects were investigated to find surplus or deficit for each project. These surplus and deficit figures were then summarised to find out the financial effect of cooperating with IPPs in generating geothermal electricity for 2018 and 2019. It was then found that cooperation between PLN and geothermal IPPs in delivering electricity for the people in Indonesia will be likely to cause PLN to suffer losses in the first and second year of operation (2018 and 2019). PLN has to pay IPPs much more for the electricity purchase than their proceeds from selling the electricity. However, this is not a fiscal risk yet until it is compared with PLN's financial capacity. The following chapter will investigate the financial impact on PLN from developing geothermal power plants.

Chapter 6
Debt Guarantee Simulation Model

6.1 Introduction

The previous chapter implemented the second simulation model, the Business Viability Simulation Model. This model's purpose is to estimate the financial impact of PLN when it purchases geothermal electricity from IPPs and retails it to its consumers. From this kind of business, PLN will be likely to suffer a deficit for 2018 and 2019. In this chapter, simulation with the third model, the Debt Guarantee Simulation Model, will be conducted. This model is intended to forecast the financial impact to PLN when it develops geothermal power plants. The model framework will be presented, including how to estimate cost and revenue, and then applied to three geothermal projects which received a Debt Guarantee and are planned to operate in 2019. By developing geothermal power plants, PLN will be exposed to geothermal risk. This risk is reflected in the probability distribution of the cost variables.

6.2 Model Framework

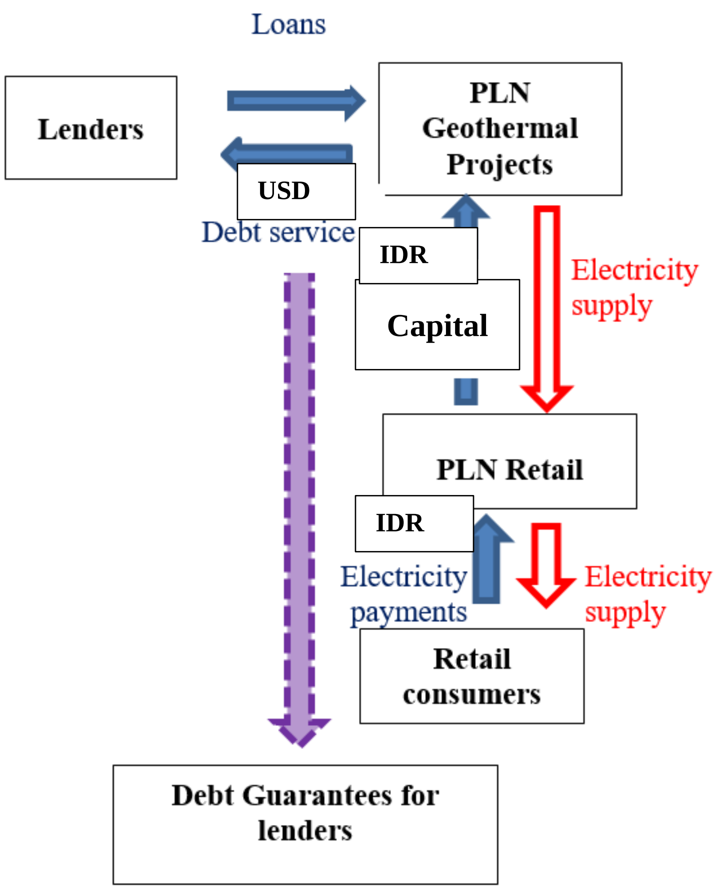
When PLN build a geothermal power plant financed by lenders, the lenders need to be assured that PLN will be able to service the debt, so the government provides a Debt Guarantee. In this scheme, lenders provide PLN with money to develop a geothermal project. PLN will service the debt from the project's income. The project will generate income when it can sell the electricity to PLN's customers so PLN can only start to pay the project loan once the power plant is commercially operated.

There is no debt service and electricity supply during power plant construction. If during the operation period, PLN fails to service the project debts, the government will take over these debt obligations because of its Debt Guarantee policy. This guarantee policy was established because in order to get any additional electricity supply, PLN does not buy from IPPs but builds its own power plant. The additional power plants are treated as PLN's additional projects. Considering its financial situation, in order to achieve this, PLN needs to find financing in the form of loans. To enhance PLN's creditworthiness, the government provides a Debt Guarantees to the lenders. To forecast the Debt Guarantee, a Monte Carlo simulation was conducted under a set of assumptions:

a. The repayment instalments of the loans will not start until the power plant has commenced commercial operation.
b. It takes five years to construct and develop the power plant before it ready, and
c. The first batch of power plant development is in 2015, so the first commercial operation and the first debt service will be in 2020.

The debt payment will be sustainable if the projects have earnings which can pay the debt services. In 2019, there will be three geothermal projects owned by PLN that can start to pay the projects' debts.

Figure 6.1 Debt Guarantee Scheme



From the geothermal project point of view, the project can generate a surplus if the net electricity payment from retail consumers exceeds the debt service for the same particular year. In this surplus condition, there will be no fiscal risk on the guarantee. If the payment from the retail consumers is less than the debt service, the project should find funding from the corporate funding. It means that PLN needs to pay the debt from its consolidated income. Normally, a project loan should be paid from the project's revenue, but in this case, when PLN as a subsidiary company of PLN cannot service the loans, PLN as parent company needs to take over the obligation. If PLN consolidated revenue is sufficient to tackle the obligation, there will be no Debt Guarantee exposure, but if it is not, there will be a fiscal risk as the guarantee will be executed which makes the government pay the rest of the debt service obligation. Moreover, if PLN develops a geothermal power plant, PLN bears a geothermal risk as well as a financial risk. However, PLN cannot charge this risk premium to its customers since the retail price is regulated.

6.2.1 Revenue

Revenue of the power plant is equal to the regulated price times the generated electricity. The generated electricity depends on the power plant capacity, capacity factor and hours of operation. This study assumes that the capacity factor is equal to the take or pay capacity (80-90%) and hours of operation are the same as the IPP's hours in a year (8760 hours) so a PLN geothermal project's revenue can be formulated as follows:

$$PR_t = Cap_t \, CF_t \, 8760 \, ERP_t \tag{6.1}$$

Where:

PR_t : PLN power plant revenue, year t

CF_t : Power plant capacity factor, year t

The retail electricity price is based on the 2017 price regulated in Menteri Energi dan Sumber Daya Mineral Indonesia (2016), then escalated based on Indonesian inflation for 2018 onward.

$$ERP_t = (1 + Inf_t)ERP_{t-1} \tag{6.2}$$

Where:

Inf = Indonesian Inflation rate

PLN's geothermal power plant costs consist of capital expenditures (Capex) and operating expenditures (Opex). Each component of these expenditures is based on the 2014 price then escalated based on the U.S. inflation rate, the Indonesian inflation rate, or changes in the Manufacturing Unit Value (MUV) index.

6.2.1.1 Cost

Power plant costs can be differentiated between capital expenditures and operating expenditures. Capital expenditures mostly occur before operation while operating expenditures are related to power plant operation and maintenance. Geothermal power plant development in Indonesia needs around five years. In the first year, geological and geoscience expenditures are disbursed followed by exploration and appraisal costs in the second year. The next stage is the development stage when development costs are spread into 20%, 40%, and 40% during years three, four and five respectively. All of the capital costs are then depreciated during the concession period (Asian Development Bank & The World Bank 2015; Castle Rock Consulting 2010; Japan International Cooperation Agency, West Japan Engineering Consultants Inc & Ministry of Finance Indonesia 2009). According to Indonesian Geothermal Law (Republic of Indonesia 2014), the geothermal concession is 30 years. Table 6.1 shows the detail of these costs.

Table 6.1 Geothermal power plant capital expenditures

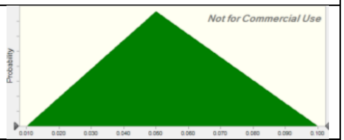
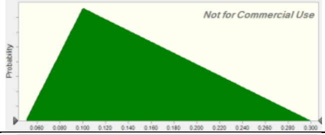
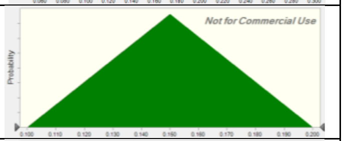
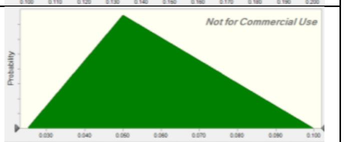
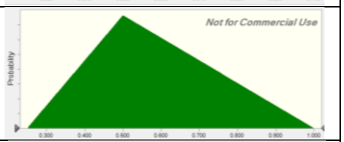
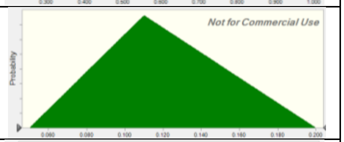
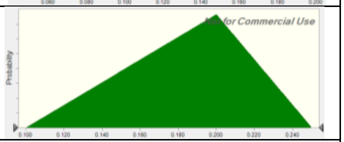
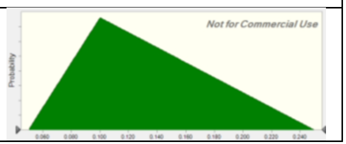
Capital expenditure	#	unit
Geology and Geoscience		
Legal	1	#
PPA Negotiation	1	#
Permitting	1	#
Mobilisation for Field Work	1	#
Geoscientific	1	#
Environmental/Social	1	#
Land Access (Rights)	1	
Owner/Developers' Costs	1	% sum of cost
Exploration and Appraisal		
Legal Costs	1	
Site Survey	1	
Land Acquisition	5	km2
Geotechnical	1	
Civil Works and Infrastructure	1	#
Rig Mobilisation & De-mobilisation	1	USD
Well Drilling	2	wells
Well Testing	2	wells
Site Operations	1	
Pre-Feasibility/Feasibility Studies	1	
Grid Connection Study	1	
Financing Tasks	1	
Procurement Costs	1	
Asset Insurance (Including Wells)	1	% sum of cost
Developer's General & Administration	NA	% sum of cost
Development Stage		
Legal	1	
Steam Field Costs (SAGS)	5	USD m / MW
Well Drilling (production)	[a])	wells
Well Drilling (injection)	1	
Well Drilling (makeup) - USD share	75%	
Well Drilling (makeup) - IDR share	25%	
Well Testing	1	well
Rig Mobilisation & De-mobilisation	1	USD
Construction Cost	5	

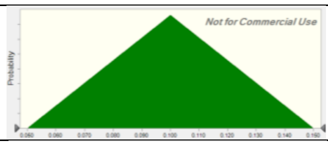
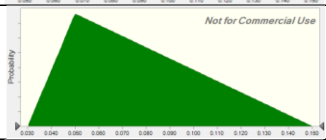
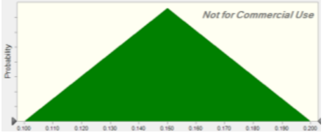
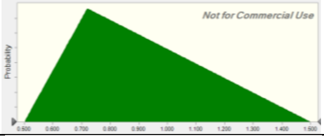
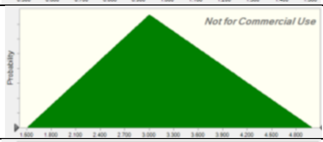
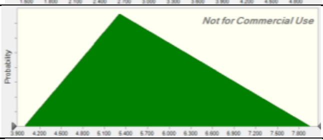
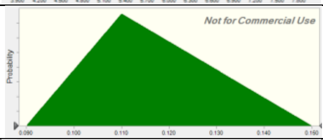
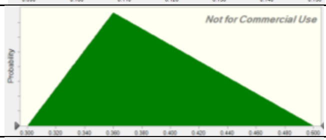
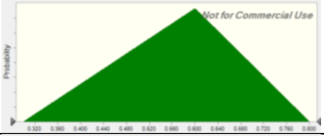
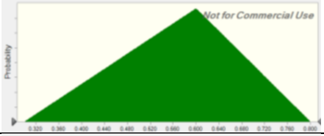
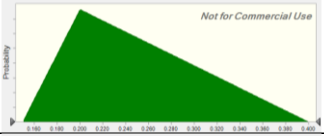
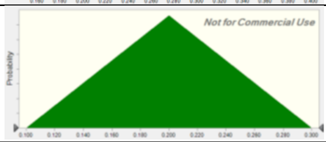
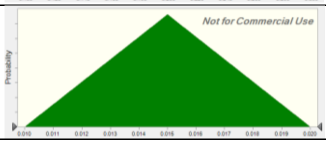
[a]) number of drilling well depends on power plant capacity

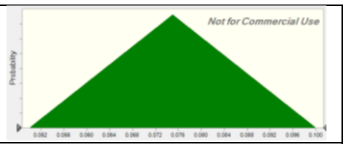
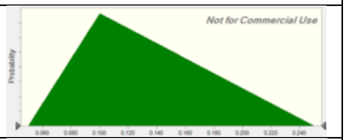
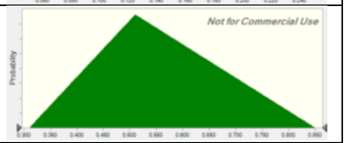
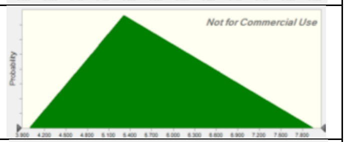
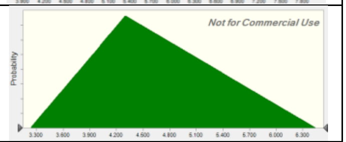
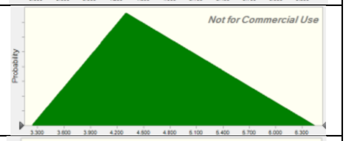
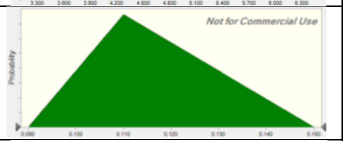
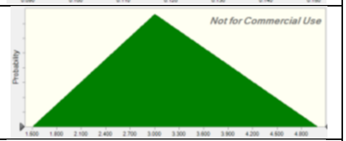
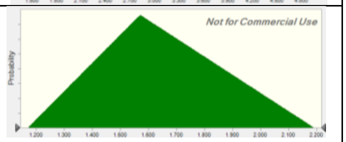
Source: Asian Development Bank and The World Bank (2015); Castle Rock Consulting (2010).

Based on Castle Rock Consulting's (2010) investigation into all geothermal sites in Indonesia, these costs are not certain: most of them follow a triangular distribution (see Table 6.2). A triangular distribution is a continuous probability distribution curve that looks like a triangle, so that values near the minimum and maximum are less likely to occur than those near the most likely value. It is measured by its minimum, maximum, and most likely values and so it has definite upper and lower limits which can avoid extreme values (Petty & Dye 2017). According to Charnes (2007), this triangular distribution is commonly used when the minimum, maximum, and most likely values are known and have fixed minimum and maximum values.

Table 6.2 Probability distribution of geothermal power plant cost in USD million

Capital Expenditures	Cost (USD million)			Probability Distribution Chart
	Min	Mode	Max	
Geology and Geoscience				
Legal	0.010	0.050	0.100	
PPA Negotiation	0.050	0.100	0.300	
Permitting	0.100	0.150	0.200	
Mobilisation for Field Work	0.025	0.050	0.100	
Geoscientific	0.250	0.500	1.000	
Environmental/Social	0.050	0.110	0.200	
Owner/Developers' costs [1])	0.475	0.456	0.049	
Exploration and Appraisal				
Legal Costs	0.050	0.100	0.250	

Site Survey	0.050	0.100	0.150	
Land Acquisition	0.030	0.050	0.150	
Geotechnical	0.100	0.150	0.200	
Civil Works and Infrastructure	0.500	0.720	1.500	
Rig Mobilisation and De-mobilisation	1.500	3.000	5.000	
Well Drilling	3.990	5.310	7.960	
Well Testing	0.090	0.110	0.150	
Site Operations	0.300	0.360	0.500	
Pre-Feasibility/Feasibility Studies	0.300	0.600	0.800	
Grid Connection Study	0.050	0.100	0.200	
Financing Tasks	0.150	0.200	0.400	
Procurement Costs	0.100	0.200	0.300	
Asset Insurance (Including Wells) [2])	0.010	0.015	0.020	

Developer's General and Administration [2])	0.050	0.075	0.100	
Cost Development Stage				
Legal	0.050	0.100	0.250	
Steam Field Costs (SAGS)	0.310	0.510	0.850	
Well Drilling (production)	3.990	5.310	7.960	
Well Drilling (injection)	3.232	4.301	6.448	
Well Drilling (make up) - USD share	3.232	4.301	6.448	
Well Testing	0.090	0.110	0.150	
Rig Mobilisation and De-mobilisation	1.500	3.000	5.000	
Construction Cost	1.170	1.570	2.190	

Notes:

[1]) As a percentage of the sum of other costs in the geology and geoscience stage.

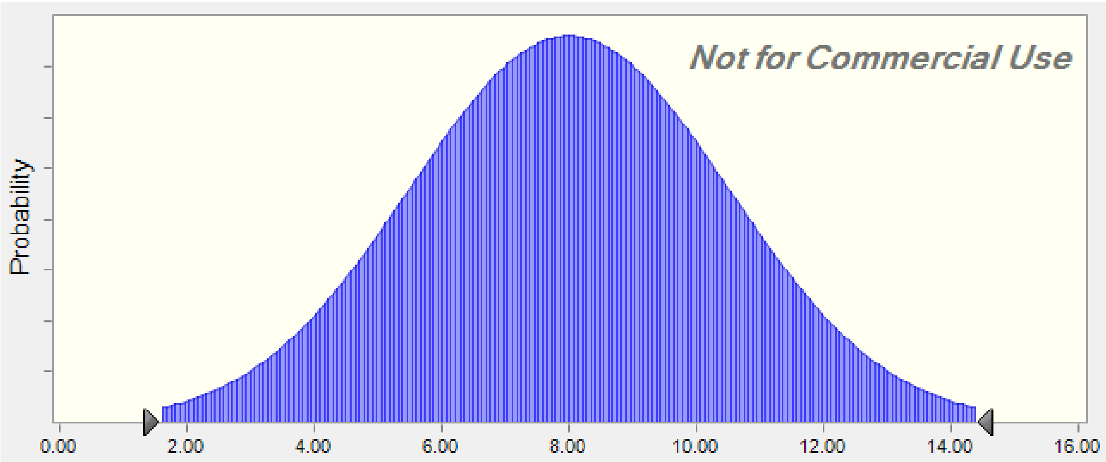
[2]) As a percentage of the sum of other costs in the exploration and appraisal stage.

Source: Author's calculation and Castle Rock Consulting (2010).

There are some other capital costs which are related to other costs. These costs include land access, around 5% of the sum of cost at the geology and geoscience stage (Castle Rock Consulting 2010), and well drilling for makeup wells in IDR, around 25% of the total make up drilling cost (Asian Development Bank & The World Bank 2015, p. 41).

Geothermal well production capacity is measured by how much gross electricity it can generate (Mega Watt electricity – MWe). The geothermal power plant capacity represents the sum of geothermal well capacity drilled. International Finance Corporation (2013) examined 1,087 geothermal wells in the world and found that the wells' capacities are varied and positively skewed of 1.64 with an average capacity per well of 7.3 MWe and a maximum capacity of 52 MWe. For the case of Indonesia, the Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) found that the well capacity follows a normal distribution, with a minimum capacity of 1.6 MWe and a maximum capacity of 14.4 MWe, and with an average capacity of 8 MWe and a standard deviation of 2.5 (see Figure 6.2).

Figure 6.2 Probability Distribution of Geothermal Well Capacities in Indonesia



Source: Author's simulation from Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009) data.

The number of wells also depends on drilling success rates as a low success rate makes PLN drill more wells. According to Deloitte (2008); Japan International Cooperation Agency, West Japan Engineering Consultants Inc and Ministry of Finance Indonesia (2009), drilling success in the exploration phase is around 50-68% with a most likely value of 59%. In the next phase, the success rate increases to 60-88% with the likeliest rate of 74% and during the production phase the success rate achieves its maximum probability, a minimum of 70% and a maximum of 96% with a mode of 83%.

During the development period, these capital expenditures are not fixed, as it might increase or decrease. Asian Development Bank and The World Bank (2015) found some proxies to predict the cost of inflation and deflation including Manufacture Unit Value

(MUV) index, U.S. GDP deflator, and Indonesian GDP deflator. The MUV index is an escalation price proxy for imported manufactured goods from developing countries in USD terms (World Bank 2014). In this study, the MUV index will be used to estimate the future price of cost items which mostly consist of imported goods including production well drilling cost, 75% of makeup well-drilling cost, steam above ground system (SAGS) cost, and the construction cost of the power plant. As for the other capital costs, they will be referred to the U.S. or Indonesian GDP deflator based on their denomination terms (Asian Development Bank & The World Bank 2015). As this power plant development requires payment both in USD and IDR, exchange rate risk needs to be internalised in the capital cost. Almost all the capital costs occurred in the first five years before operation except makeup well cost. This cost is for maintaining wells, about once every five years after the power plant is commercially operated (Asian Development Bank & The World Bank 2015; Japan International Cooperation Agency, West Japan Engineering Consultants Inc & Ministry of Finance Indonesia 2009). Another cost incurred in the operation period, operation and maintenance expenditure, starts to occur and during 30 years of operation, this cost also fluctuates, so will be escalated based on U.S. and Indonesian GDP inflators. The Asian Development Bank and The World Bank (2015) found that 75% of these costs are in IDR and the rest of the costs are in USD.

6.2.1.2 U.S. Inflation

This study allows geothermal power plants five years for construction and 30 years of operation. An important factor affecting the financial outcome of these projects is inflation. A stable inflation rate is needed to reduce cost uncertainty. Higher levels of certainty on inflation rates is vital for improving the predictability of budgetary outcomes and reducing modelling risk. Under high inflation, nominal costs will soar, which, if left uncompensated, will reduce a project's profitability. Therefore, in agreement with Nagarajan (2004, p. 400), this presents a compelling argument for including inflation in the research model.

This simulation model calculates the capital cost as well as operation and maintenance cost increases. These costs are denominated in IDR and USD, based on their normal behaviour. During the concession period, IDR denominated costs are escalated based on the Indonesian inflation rate, whereas the USD denominated costs are indexed to U.S. Inflation.

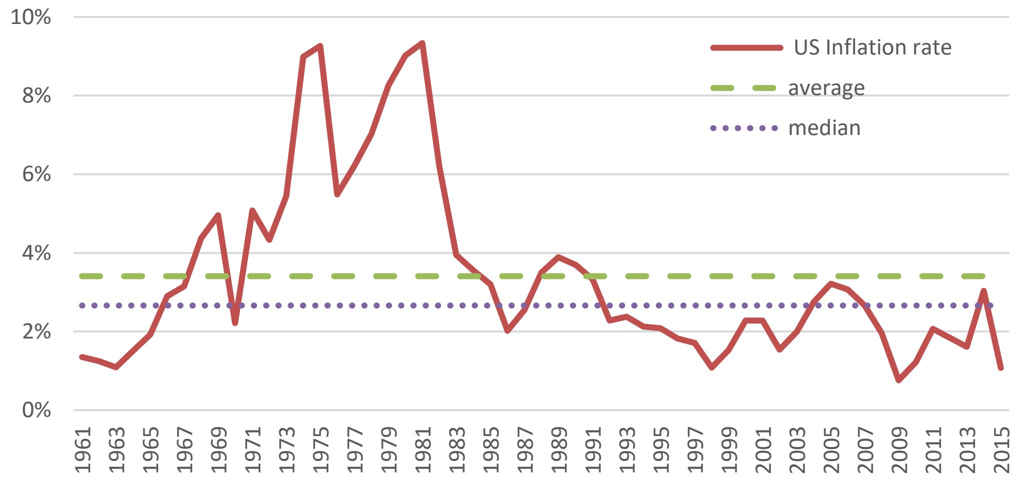
Table 6.3 Descriptive statistics of U.S. Inflation rates

	U.S. Inflation, % (2000 – 2015)
Observations	16
Mean	2.08
Median	2.03
Minimum	0.76
Maximum	3.22
Std. Deviation	0.74
Skewness	(0.10)

Source: Author's calculation based on data from World Bank (2017) and Statistics Indonesia (2017).

Figure 6.3 below shows that, similar to Indonesia, the USA also suffered crises, in 1975 and 1980. The highest inflation of 9.26% in 1975 and 9.34% in 1981 were due to U.S. banking crises in these years (Bordo & Haubrich 2017).

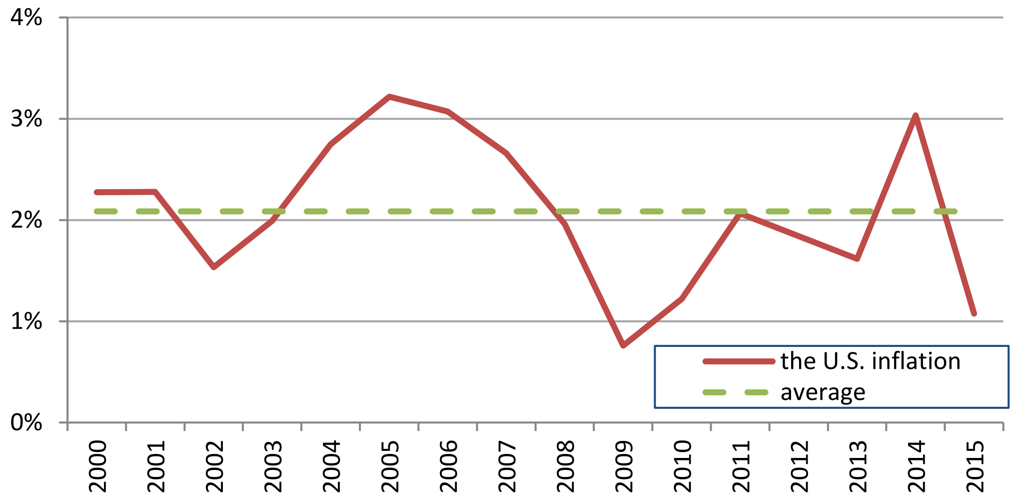
Figure 6.3 U.S. inflation, 1961-2015



Source: World Bank (2017).

In order to focus on the period addressed in this study, the U.S. inflation rates for 2000-2016 are presented in Figure 6.4 below. The U.S. was able to maintain an inflation rate of under 3.5%, with fluctuated rates of between 0.76% to 3.22%. The average inflation rate was 2.08%, which was much lower than the Indonesian average. The volatility of inflation rate in the U.S. was also lower than in Indonesia, as it showed a standard deviation value of 0.74% compared to Indonesia's 3.83%.

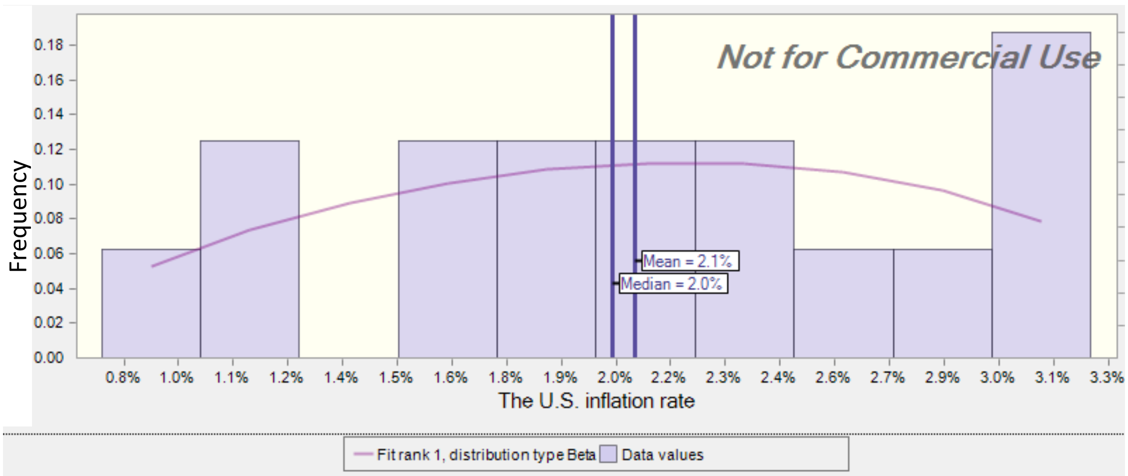
Figure 6.4 U.S. inflation, 2000-2015



Source: World Bank (2017).

The average inflation rate in the U.S. was close to its median value of 2.03%. A histogram of the U.S. inflation rate shows that these rates were only slightly skewed at -0.10. Therefore, the U.S. inflation rate will more likely be around the median value, which is just over 2% (see Figure 6.5).

Figure 6.5 Frequency distribution of U.S. Inflation, 2000-2015



Source: Author's calculation from World Bank (2017) data.

Similar to Indonesian inflation rates, the closest probability distribution for U.S. inflation has a Beta distribution (minimum value of 0.5%, maximum 3.5%, Alpha 1.77, Beta 1.57) based on the Anderson-Darling test results (see Figure 6.5).

6.2.1.3 Changes in Manufactures Unit Value (MUV) Index

As discussed in the previous chapter, it was assumed in the model that geothermal power plant construction needs five years. However, during this period, materials, labour and overhead costs might not be the same price. Besides inflation, another proxy to assess cost escalation in the geothermal power plant costs is the MUV Index, which is the manufacturing unit value of manufactured product export prices from 20 industrial countries (Chen, Y-c & Lee 2013) charged to developing countries (Iqbal & James 2002, p. 79). Both cost escalations and devaluations are reflected in the changes of the MUV Index. The Asian Development Bank and The World Bank (2015, p. 51) escalate geothermal power plant cost based on the MUV Index. Changes in the MUV Index were calculated with the following formula:

$$Changes\ in\ MUV\ Index_{\ year\ i} = \frac{MUV\ Index_{\ year\ i} - MUV\ Index_{\ year\ i-1}}{MUV\ Index_{\ year\ i-1}}\ x\ 100\% \qquad (6.3)$$

World Bank (2014) was the most recent publication of the index. Based on the data, it was found that on average, for the period of 2000-2013, every year the index grew by 1.81% with a median value of 2.53%. The range width is around 15% from -6.20% to 8.95% with 4.58% standard deviation (see Table 6.4).

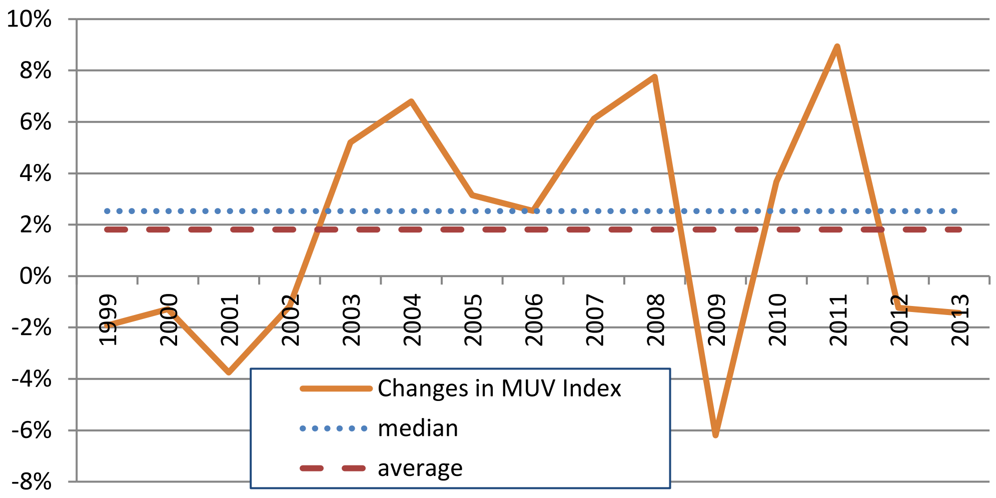
Table 6.4 Descriptive statistics of changes in MUV Index, 1999-2013

Observations	15
Mean	1.81%
Median	2.53%
Minimum	-6.20%
Maximum	8.94%
Std. Deviation	4.58%
Skewness	-0.03

Source: Author’s calculation based on World Bank (2014).

As shown in Figure 6.6, the largest increase during the period 1999-2013 (just under 9%) was in 2011, while the most significant decrease was in 2009 at -6.20%. Since 2000, the index has been fluctuating with a standard deviation of 4.58%. In 2009, the index fell by 6.20% but then increased sharply for the next year, reaching a high of 8.94% before falling again (see Figure 6.6).

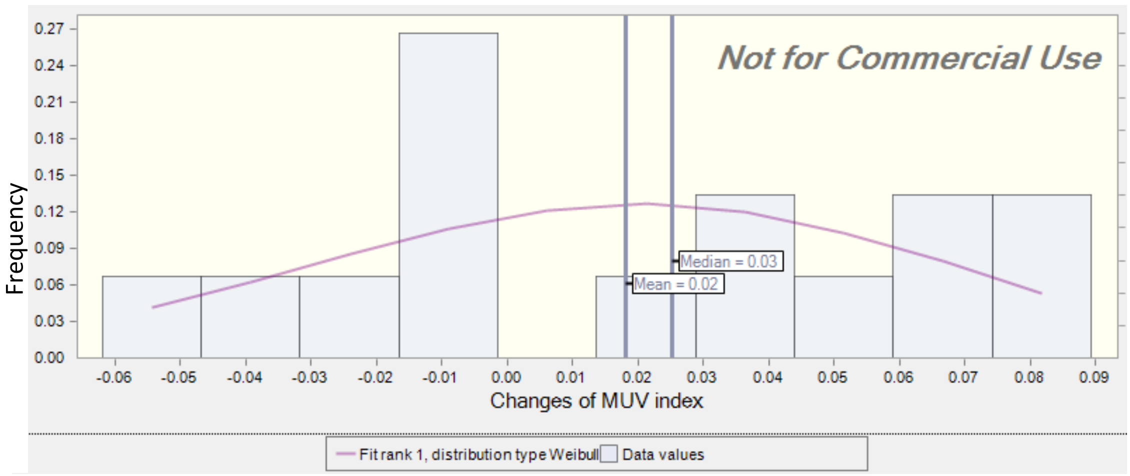
Figure 6.6 Changes in MUV Index, 1999-2013



Source: World Bank (2014).

As shown in Table 6.4, skewness was almost zero, indicating a near symmetric distribution. However, its histogram (see Figure 6.7), shows that in reality, most data was below centre measures. Therefore, for financial simulation, data distribution needed to be fitted. When this was done, it was found that the data behaviour resembles a Weibull distribution (see Figure 6.7).

Figure 6.7 Frequency distribution of MUV Index, 1999-2013



Source: Author's calculation from World Bank (2014).

With a location of 0, a scale of 0 and shape parameter of 3.7 the Weibull distribution has the lowest Anderson-Darling and Chi-Square value when compared to the other distributions. Therefore, the MUV index is likely to follow the Weibull distribution.

6.2.2 Debt Obligation

As it was assumed that 70% of the project costs are financed by debt, some the projects' net income needed to be allocated for debt repayments. Most of PLN's project loans are from the Japan Bank for Inter-Cooperation (JBIC). The standard JBIC interest rate is the 6 month London Interbank Borrowing Offer Rate (LIBOR) for USD plus a risk premium of 0.500% (The Japan Bank for International Cooperation 2017a). Because 6 month LIBOR rates fluctuate, PLN will be exposed to interest rate risk (The Federal Reserve Bank of St. Louis 2017). If PLN's geothermal projects do not have revenue proceeds to pay its debt, PLN has to tackle the obligation. However, if PLN is unable to fulfil all or part of this debt service, the government has to pay the remaining obligation as mandated by the Debt Guarantee policy. Therefore, this arrangement puts the government at fiscal risk.

Geothermal power plants are capital-intensive projects which adapt project finance (Ngugi 2012). Capital can be obtained from equity and debt, the latter being cheaper than equity as it has a tax shield (Graham 2000). In project finance, the debts are non-recourse and create more value than corporate debt (Esty 2003). The debt covers most of the capital need for the projects; around 70-90% (Yescombe 2002, p. 7).

The interest payments on debt are usually benchmarked to LIBOR (Snider & Youle 2010). In Indonesia, many geothermal projects sign loan agreements with the Japan Bank for International Cooperation (JBIC) such as the Sarulla (The Japan Bank for International Cooperation 2013) and Muara Laboh (The Japan Bank for International Cooperation 2017b) geothermal projects. Therefore, this study assumed that project loans are based on the JBIC standard loan condition. Based on the standard loan condition for Indonesia, the interest follows the 6 month LIBOR rate (The Japan Bank for International Cooperation 2017a). A high LIBOR results in a high-interest expense. Since interest during construction is capitalised, a high LIBOR creates a high cost of capital. In the last decade, LIBOR fluctuated between 0.32% and 1.96% with a standard deviation of 0.36. The average and median values have 15 basis points difference, so it indicates that LIBOR does not follow a normal distribution (see Table 6.5).

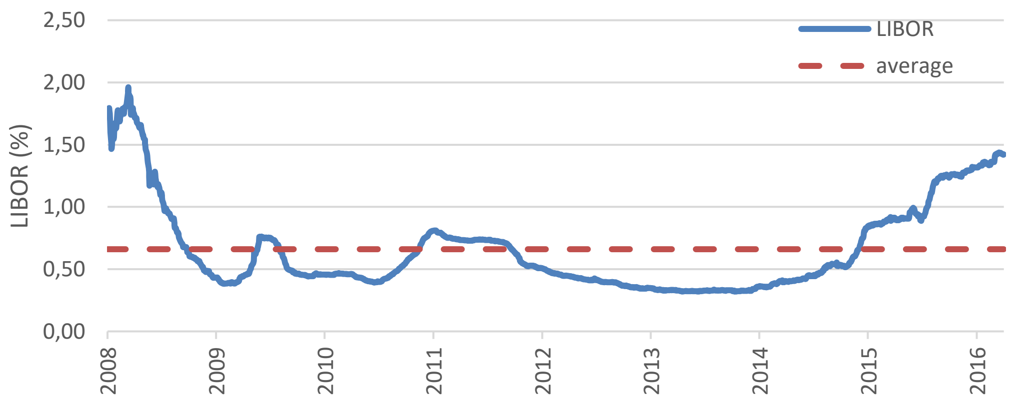
Table 6.5 Descriptive statistics of 6-month LIBOR based on U.S. dollars

Observations	2085
Mean	0.66%
Median	0.51%
Minimum	0.32%
Maximum	1.96%
Std. Deviation	0.36%
Skewness	1.44

Source: Author's calculation based on The Federal Reserve Bank of St. Louis (2017) data.

Overall, during 2009 to 2015, LIBOR values were low, below its average value. The highest rate in this period was on March 10th, 2009. After around five years, it then decreased to the lowest point (0.32%). However, the current trend of LIBOR is above the average value of 0.66% (see Figure 6.8).

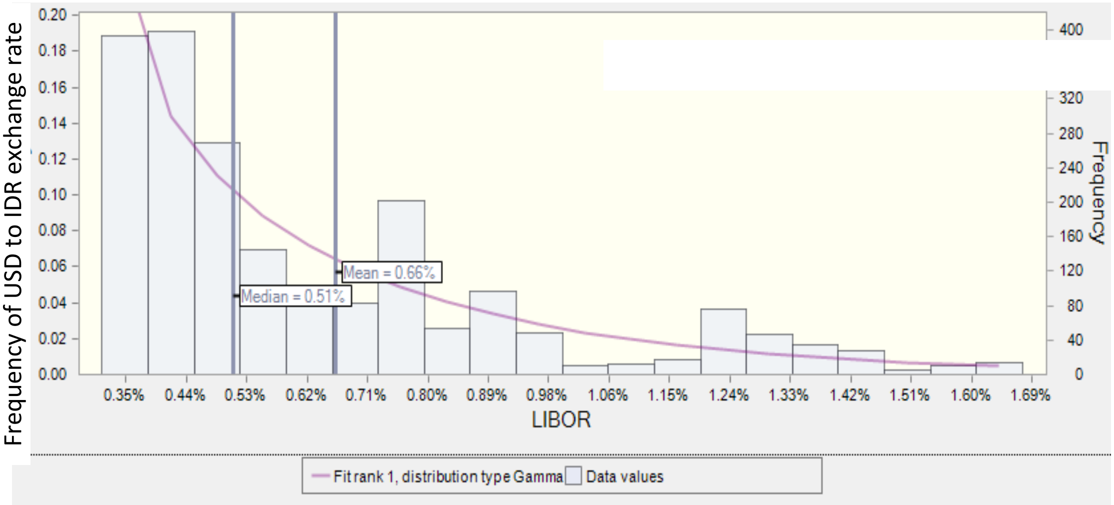
Figure 6.8 LIBOR, December 31st, 2008 – March 31st, 2017



Source: Author's calculation from The Federal Reserve Bank of St. Louis (2017).

The LIBOR was positively skewed (see Figure 6.9) at 1.44. Therefore, it is expected that the value will be low in the future. However, there has been an upward trend of LIBOR since August 2014. If this trend continues, it is possible that LIBOR will increase further.

Figure 6.9 Frequency of LIBOR



Source: Author's calculation from The Federal Reserve Bank of St. Louis (2017) data.

Gamma distribution is the best fit for the LIBOR distribution based on goodness-of-fit test results. Therefore, this study will assume a gamma distribution of location 0.32%, scale 0.43% and shape 0.81 to forecast the LIBOR value.

6.2.3 Surplus/(deficit) from PLN geothermal projects

At the geothermal project level, if the project's revenue is more than the project's costs, the surplus can be used to service the debt. If the surplus is more than or equal to the debt service for the same period, the debt guarantee will not be called. However, if a power plant suffers a deficit, the holding company, PLN, has to pay all the project debt obligations. If it is in surplus, PLN only needs to pay the difference between this surplus and the debt obligation for a year.

If $PR_t - PC_t \geq 0,\ PS/D_t = PR_t - PC_t - DS_t$ (6.4)

If $PR_t - PC_t < 0,\ PS/D_t = -DS_t$ (6.5)

Where:

PR_t = PLN geothermal project's revenue, year t

PC_t = PLN geothermal project's costs, year t

DS_t = PLN geothermal project's debt service, year t

6.3 Geothermal Projects

PLN has been developing three geothermal projects which are planned to be operational in 2019. To develop these power plants, PLN acquires project loans, and the lenders received Debt Guarantees. There are three geothermal projects that will be simulated in this Debt Guarantee model: the Ulumbu 5, Mataloko, and Atadei projects. A profile of each of power plant can be seen in Table 6.6.

Table 6.6 Profiles of the simulated debt guarantee geothermal projects

No	Geothermal projects	Capacity (MW)	Region	Developer	Type of Guarantee	COD
1.	***Ulumbu 5***	10	II	PLN	Debt Guarantee	2019
2.	***Mataloko***	20	II	PLN	Debt Guarantee	2019
3.	***Atadei***	5	II	PLN	Debt Guarantee	2019

Source: Menteri Energi dan Sumber Daya Mineral Indonesia (2014); Menteri Keuangan Indonesia (2011b); PT. PLN (Persero) (2015).

6.3.1 Ulumbu Geothermal Project

The Ulumbu geothermal project is located in Flores, Eastern Nusa Tenggara province in the eastern part of Indonesia. It is considered a small power plant, 10 MW, so it has not benefited from economies of scale. As a result, its generation cost per MW might be higher than a more substantial capacity geothermal project. On the other hand, since PLN has to sell electricity with the same price across all regions in Indonesia, the generation cost might exceed the retail price.

6.3.1.1 Project Revenue

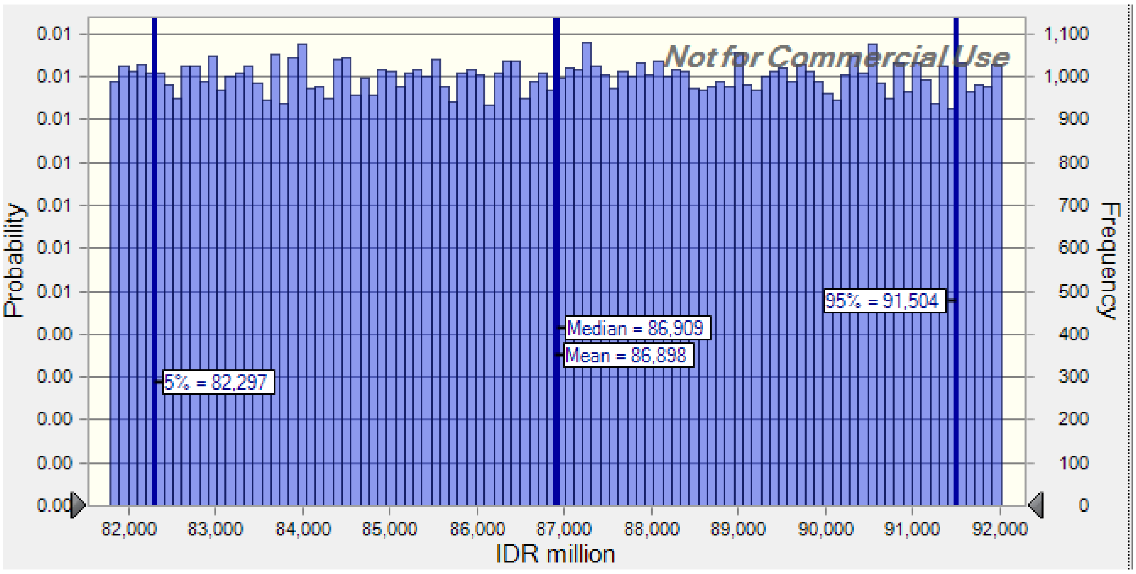
It is estimated that the Ulumbu project will generate revenue for PLN around IDR 87 billion for 2019. This revenue can peak to IDR 92 billion but also can plummet to IDR 82 billion.

Table 6.7 Ulumbu project revenue for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	86,905
Mean	86,898
Median	86,909
Standard Deviation	2,942
Skewness	(0.0032)
Kurtosis	1.81
Coefficient of Variation	0.0339
Minimum	81,793
Maximum	92,017
Mean Std. Error	9

There is a 90% chance that the Ulumbu project will make revenue between IDR 82 billion to IDR 91 billion with a mean and median of IDR 87 billion. There is also a 50% chance that this projected income will be up to IDR 87 billion.

Figure 6.10 Probability distribution of Ulumbu project revenue for 2019



6.3.1.2 Project Cost

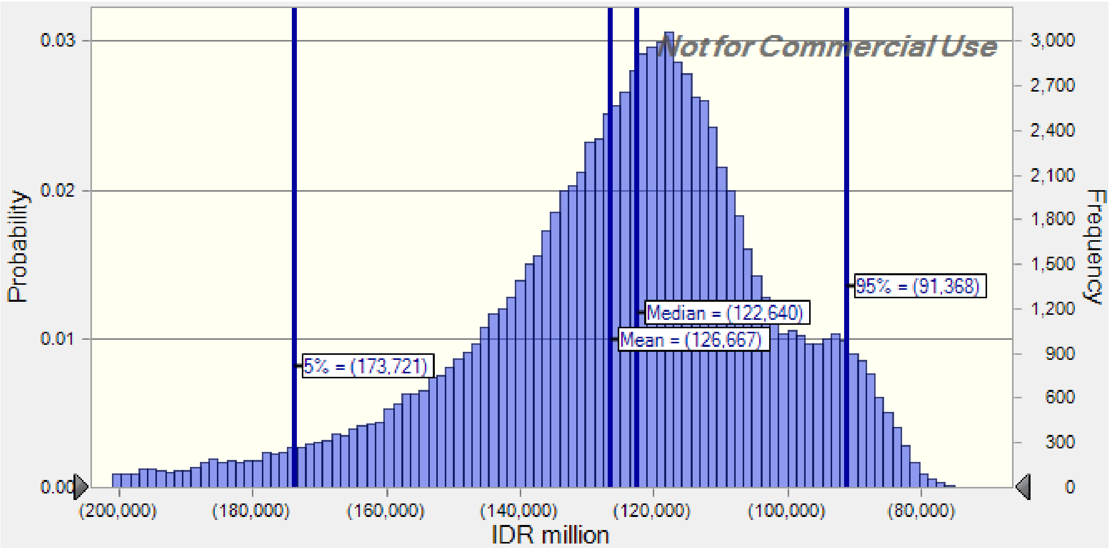
Meanwhile, in the same period, Ulumbu's cost will be around IDR (123) billion (under the base case scenario). The maximum possible cost will be IDR (691) billion and the minimum possible cost will be around IDR (70.6) billion.

Table 6.8 Ulumbu project cost for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(123,802)
Mean	(126,667)
Median	(122,640)
Standard Deviation	26,877
Skewness	(2.22)
Kurtosis	17.09
Coefficient of Variation	(0.2121)
Minimum	(691,069)
Maximum	(71,646)
Mean Std. Error	85

It is likely that the Ulumbu cost for 2019 will be around IDR (120) billion (see Figure 6.11). This is in line with the mean and median variable of IDR (127) billion and IDR (123) billion. However, there is a 5% chance that the cost will be more than IDR 175 billion.

Figure 6.11 Probability distribution of Ulumbu project cost for 2019



6.3.1.3 Operating Income Before Debt Service

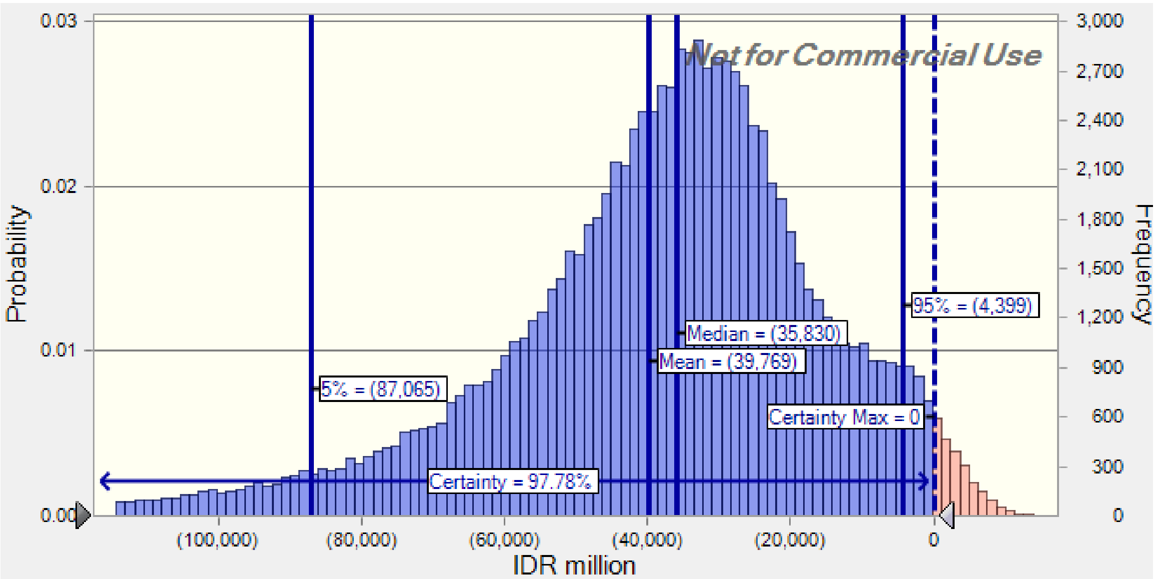
After 100,000 trials of a Monte Carlo simulation, it is more likely that the electricity earnings from the additional power plant cannot recover its costs and will suffer a deficit of up to IDR (605) billion for 2019. However, there is a chance that the project can generate a profit of up to around IDR 14.9 billion but it will only be a 2% chance (see Table 6.9 and Figure 6.12).

Table 6.9 Ulumbu geothermal project's earnings before debt service 2019 in IDR million.

Statistics	Forecast values
Trials	100,000
Base Case	(36,897)
Mean	(39,769)
Median	(35,830)
Standard Deviation	26,963
Skewness	(2.20)
Kurtosis	16.94
Coefficient of Variation	(0.6773)
Minimum	(605,321)
Maximum	14,869
Mean Std. Error	85

There is a 45% chance that this project will suffer a deficit between IDR (39.8) billion to IDR IDR (4) billion. The probability distribution of this Ulumbu project's earning before debt service will be around IDR (30) (see Figure 6.12).

Figure 6.12 Probability distribution of Ulumbu geothermal project's earnings before debt service 2019



6.3.1.4 Debt Service

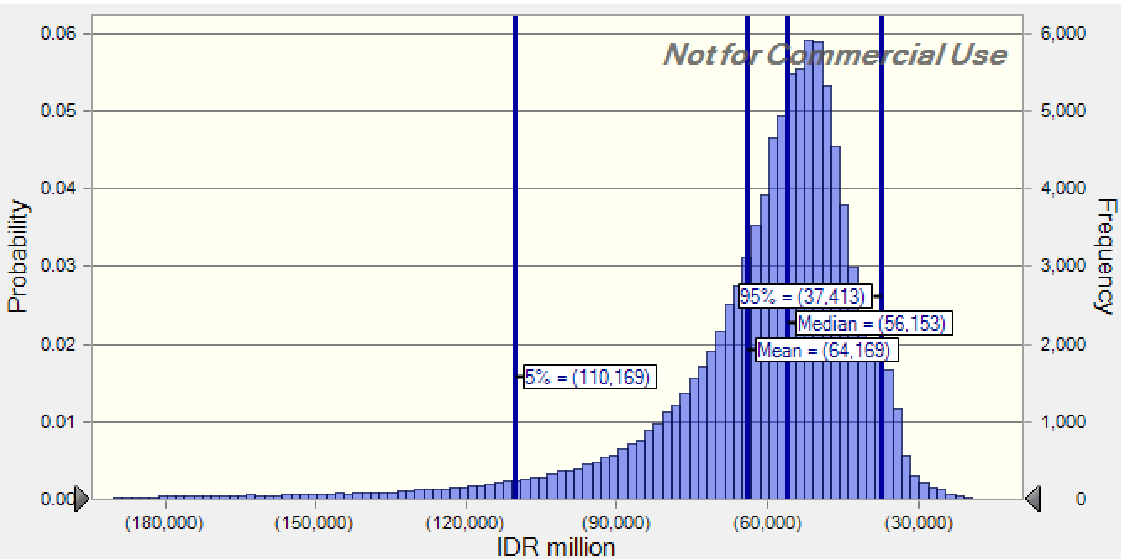
In 2019, it is expected that the Ulumbu project has to pay debt principal and interest of around IDR 53 billion (base case). However, under a 100% certainty level, the debt service payment value has a wide range, from around IDR 12.7 billion to 3 trillion (see Table 6.10).

Table 6.10 Ulumbu geothermal project's debt service for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(53,044)
Mean	(64,169)
Median	(56,153)
Standard Deviation	43,777
Skewness	(18.75)
Kurtosis	793.91
Coefficient of Variation	(0.6812)
Minimum	(3,088,024)
Maximum	(12,691)
Mean Std. Error	38

For 2019, it is likely that the debt service will be around IDR (50) billion with median value IDR (56) billion and the average value of IDR (64) billion. There is a 45% chance that the debt payment will be between IDR (56) billion and IDR (37) billion (see Figure 6.13).

Figure 6.13 Probability distribution of Ulumbu debt service 2019



6.3.1.5 Financial Impact to PLN

From Ulumbu's project development, PLN will get two financial impacts because of a deficit of the project and debt service. The deficit will make PLN disburse around IDR (36) billion (median value) to pay Ulumbu's operating cost and around IDR (56) billion for debt service (see Table 6.11).

Table 6.11 Financial impact of Ulumbu geothermal project to PLN for 2019 in IDR million

Financial Impact	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
Deficit	(39,769)	(35,830)	(605,321)	14,869	(87,065)	(4,399)
Debt Service	(64,169)	(56,153)	(3,088,024)	(12,691)	(110,169)	(37,413)

6.3.2 Mataloko Geothermal Project

The Mataloko geothermal project is a small, 20 MW, geothermal power plant project located in the Mataloko region in eastern Indonesia. It is in region 2 and is expected to be operational in 2019.

6.3.2.1 Project Revenue

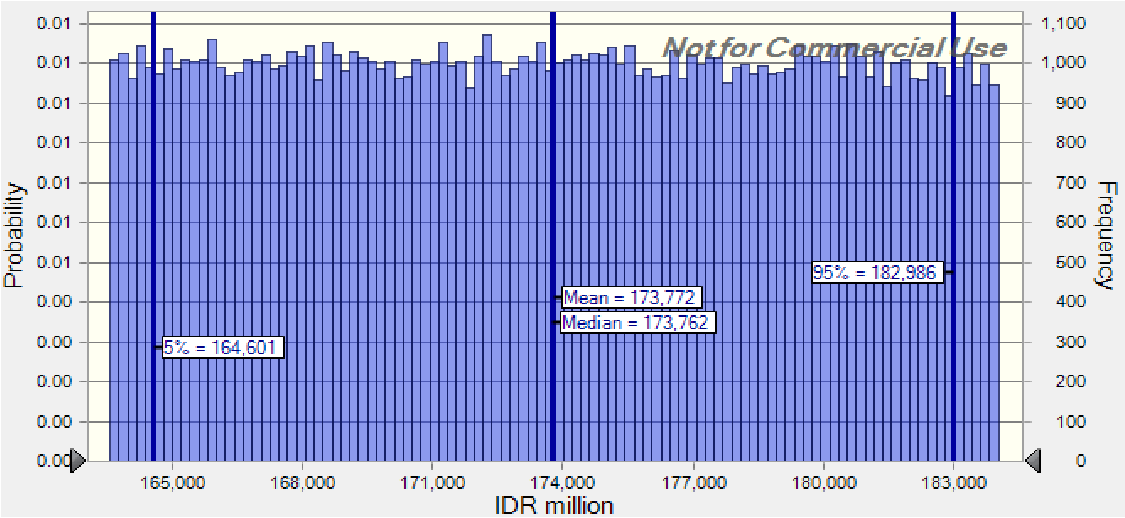
In the first operation year, the Mataloko geothermal project can make revenue of up to IDR 184 billion or at least IDR 163 billion. In the base case scenario, the projected revenue will be IDR 174 billion (see Table 6.12).

Table 6.12 Mataloko project revenue for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	173,809
Mean	173,772
Median	173,762
Standard Deviation	5,894
Skewness	5.0333E-04
Kurtosis	1.80
Coefficient of Variation	0.0339
Minimum	163,585
Maximum	184,033
Mean Std. Error	19

The Mataloko project will give PLN a steady revenue stream for an average IDR 174 billion every year. However, there is a 5% probability that the revenue will be no more than IDR 174 billion for 2019. There is also a 90% chance that the minimum revenue will be IDR 165 billion and the maximum revenue will be IDR 183 billion.

Figure 6.14 Probability distribution of Mataloko project revenue for 2019



6.3.2.2 Project Cost

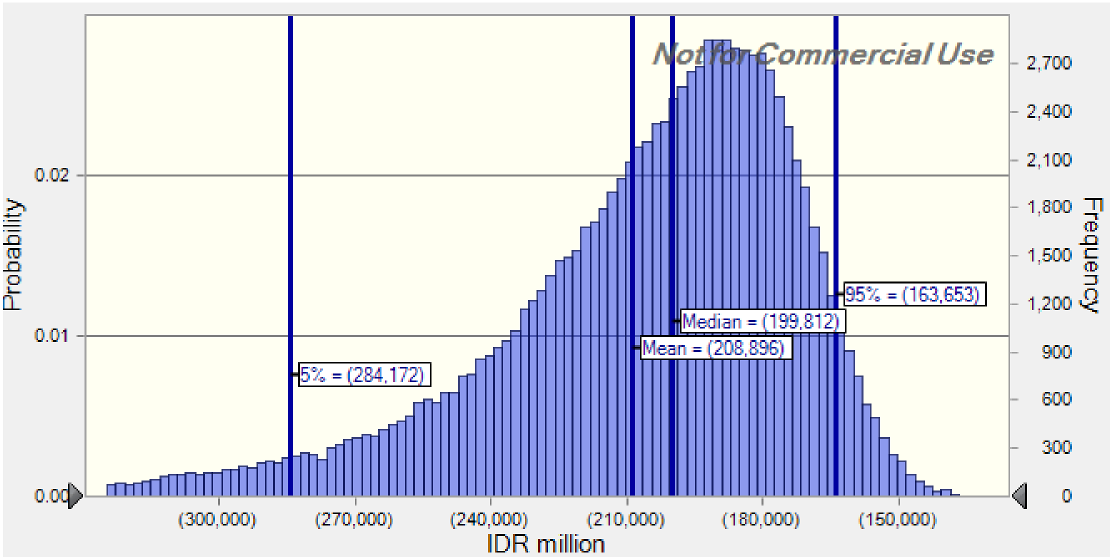
On the other hand, the Mataloko project costing more than its revenue. In the base case, the cost will be around IDR (192) billion with a possible value of between IDR (992) billion to IDR (129) billion (see Table 6.13).

Table 6.13 Mataloko project cost for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(192,386)
Mean	(208,896)
Median	(199,812)
Standard Deviation	41,655
Skewness	(2.62)
Kurtosis	18.90
Coefficient of Variation	(0.1995)
Minimum	(992,140)
Maximum	(129,363)
Mean Std. Error	132

Figure 6.15 shows that PLN needs to spend around IDR 209 billion for the Mataloko project's cost. This figure might be increased to more than IDR 284 billion with a 5% probability but with the same probability can also decrease to less than IDR 164 billion.

Figure 6.15 Probability distribution of Mataloko project cost for 2019



6.3.2.3 Operating Income Before Debt Service

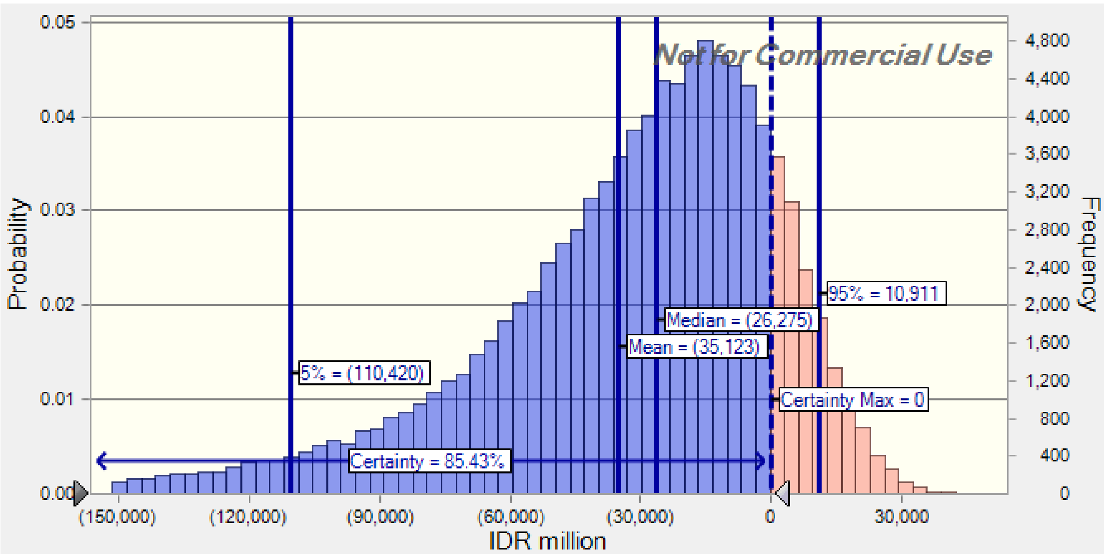
This small geothermal power plant is likely to suffer a loss, but it also has a probability of making a profit. The base case value predicts earnings of around IDR 19 billion, but the mean value predicts a much greater amount, almost double. It is forecasted that PLN's earning from the Mataloko project will be a loss of IDR (35) billion (mean value) or IDR (26) billion (median value) with the maximum possible deficit will be IDR (816) billion. However, this project might generate a surplus of up to IDR 46 billion (see Table 6.14).

Table 6.14 Mataloko geothermal project's earnings before debt service 2019 in IDR million.

Statistics	Forecast values
Trials	100,000
Base Case	(18,577)
Mean	(35,123)
Median	(26,275)
Standard Deviation	41,872
Skewness	(2.58)
Kurtosis	18.55
Coefficient of Variation	(1.20)
Minimum	(815,996)
Maximum	46,316
Mean Std. Error	85

Figure 6.16 shows that the probability distribution of the Mataloko project's earning has a long tail on the left part and a short tail on the right side, so the maximum and minimum value will be unlikely to happen. Therefore, a 90% certainty level can significantly limit the forecast value. Under this certainty level, the earnings will be from a loss of IDR (110) billion to a profit of IDR 11 billion (see Figure 6.16).

Figure 6.16 Probability distribution of Mataloko geothermal project's earnings before debt service 2019



6.3.2.4 Debt Service

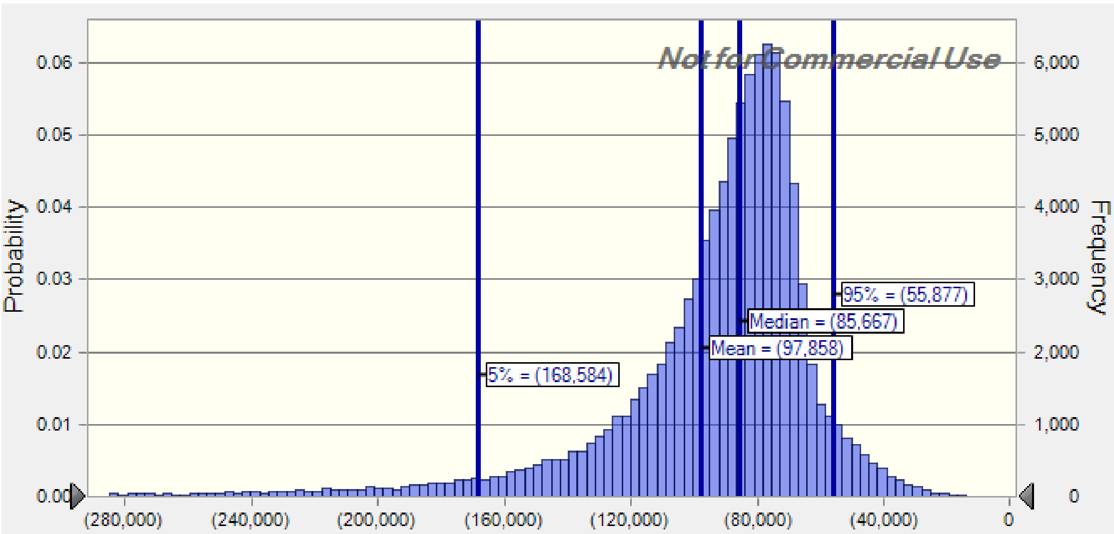
Although this project, on average, will be unable to generate profit for PLN, the project debt must be paid. The debt service for 2019 will on average will be approximately IDR (98) billion. The base case value of the debt service according to the simulation results is IDR (76) billion; the median value is IDR 86 billion. This debt service can increase to a maximum of IDR (3.8) trillion or decrease to just IDR (705) million (see Table 6.15).

Table 6.15 Mataloko geothermal project's debt service 2019 in IDR million.

Statistics	Forecast values
Trials	100,000
Base Case	(76,356)
Mean	(97,858)
Median	(85,667)
Standard Deviation	62,469
Skewness	(13.22)
Kurtosis	388.70
Coefficient of Variation	(0.6387)
Minimum	(3,834,089)
Maximum	(705)
Mean Std. Error	198

This extensive range of width will be less likely to happen as under a 90% certainty level the maximum debt service will be IDR (169) billion with a minimum value of IDR (56) billion. The probability of Mataloko's debt service being more, between IDR (3.8) trillion to IDR (169) trillion, for 2019 will be just 5% (see Figure 6.17).

Figure 6.17 Probability distribution of Mataloko debt service 2019



6.3.2.5 Financial Impact to PLN

The Mataloko geothermal project development will result in a deficit and debt payment for PLN. As this project will suffer a loss of around IDR (26) billion (median value), it cannot pay its project debt of around IDR (86) billion for 2019 (see Table 6.16).

Table 6.16 Financial impact of Mataloko geothermal project to PLN for 2019 in IDR million

Financial Impact	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
Deficit	(35,123)	(26,275)	(815,996)	46,316	(110,420)	(10,911)
Debt Service	(97,858)	(85,667)	(3,834,089)	(705)	(168,584)	(55,877)

6.3.3 Atadei Geothermal Project

Similar to the Mataloko project, the Atadei geothermal project was formerly offered to IPPs, but it turns out that PLN finally developed the project. The difference is this project will be much smaller, 5 MW, which results in a higher cost per MW.

6.3.3.1 Project Revenue

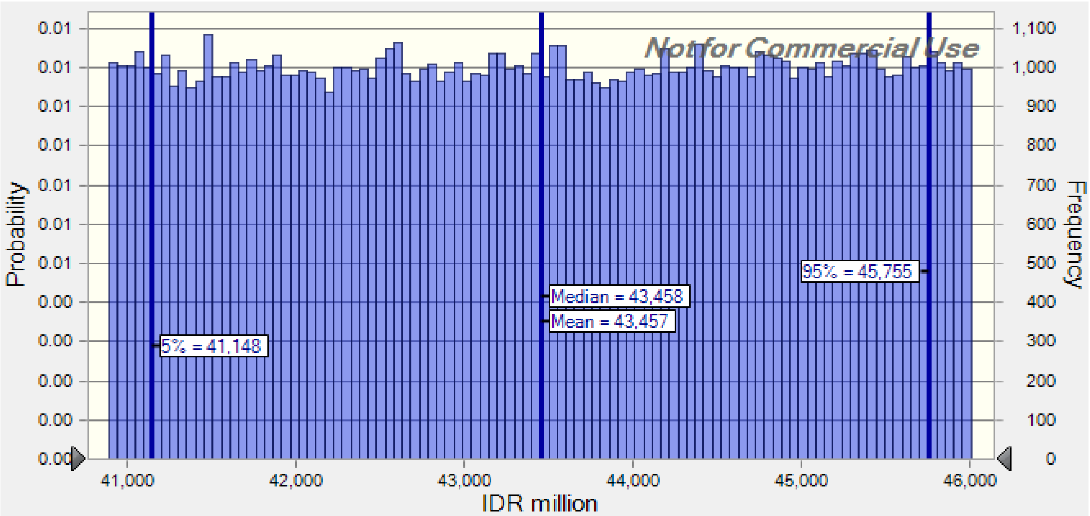
This small geothermal power plant will be able to generate at least IDR 40 billion revenue for 2019. It can even generate revenue up to IDR 46 billion.

Table 6.17 Atadei project revenue for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	43,452
Mean	43,457
Median	43,458
Standard Deviation	1,478
Skewness	5.3853E-04
Kurtosis	1.80
Coefficient of Variation	0.0340
Minimum	40,896
Maximum	46,008
Mean Std. Error	5

For 2019, there will be a 90% chance that PLN will receive revenue up to IDR 46 billion and no less than IDR 41 billion. There is a 5% chance that the revenue will be less than IDR 41 billion but more that IDR 40 million.

Figure 6.18 Probability distribution of Mataloko project revenue for 2019



6.3.3.2 Project Cost

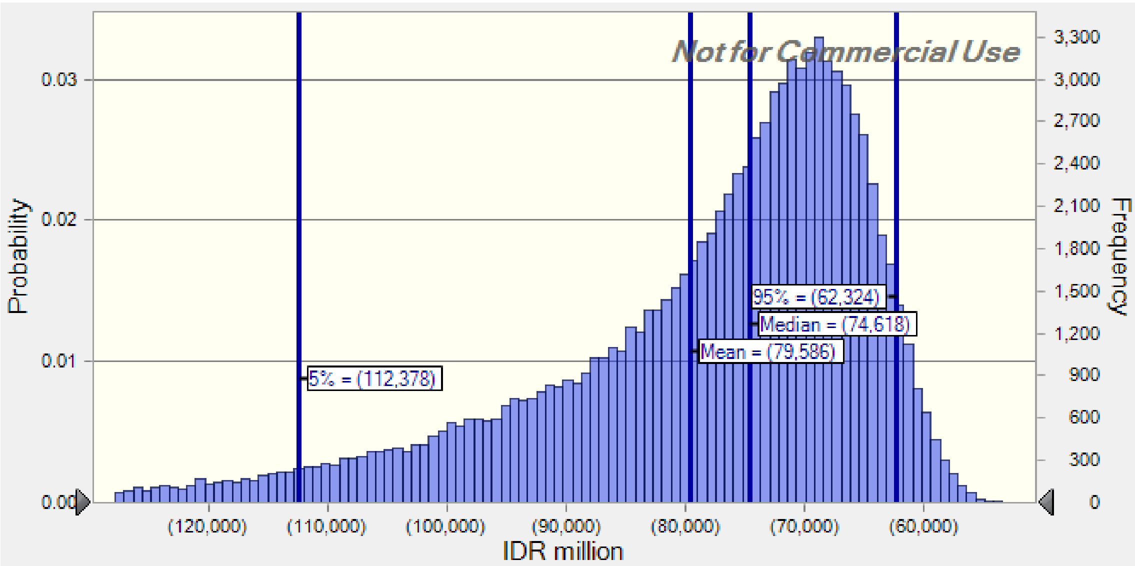
Although the Atadei geothermal project will be able to generate revenue, it will cost almost twice the revenue. For 2019, the cost will be around IDR (71) billion while the revenue will be around IDR (43) billion (in base case scenario).

Table 6.18 Atadei project cost for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(71,747)
Mean	(79,586)
Median	(74,618)
Standard Deviation	17,535
Skewness	(2.69)
Kurtosis	20.07
Coefficient of Variation	(0.2203)
Minimum	(508,417)
Maximum	(51,750)
Mean Std. Error	55

Figure 6.19 shows that Mataloko's operating cost will be around IDR (70) billion with a 45% chance that the cost will fall between IDR (75) billion to IDR (62) billion for 2019. It also indicates that the cost can be more than IDR (112) billion to IDR (508) billion (see Figure 6.19).

Figure 6.19 Probability distribution of Mataloko project cost for 2019



6.3.3.3 Operating Income Before Debt Service

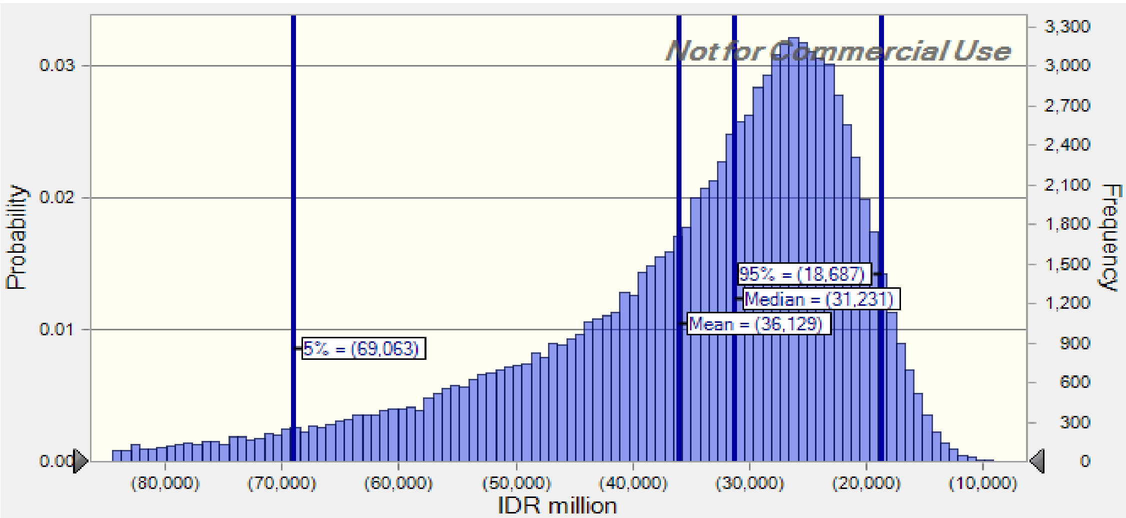
On average, before the debt payment, the project will be likely to suffer a loss of IDR (36) billion with a possible earning of loss of IDR (464) billion to IDR (7.9) billion for 2019. The results in Table 6.19 show that the base case value has a lower figure than the average value and median value (loss of IDR (32) billion).

Table 6.19 Atadei geothermal project's earnings before debt service 2019 in IDR million.

Statistics	Forecast values
Trials	100,000
Base Case	(28,295)
Mean	(36,129)
Median	(31,231)
Standard Deviation	17,569
Skewness	(2.67)
Kurtosis	19.92
Coefficient of Variation	(0.4859)
Minimum	(464,191)
Maximum	(7,820)
Mean Std. Error	56

Based on the 90% chance, the maximum deficit for PLN will be significantly cut from IDR (464) billion to just IDR (69) billion (see Figure 6.20). The figure also indicates that the deficit will be around IDR (25) billion as there is 45% chance that the deficit will be around IDR (31) billion to IDR (19) billion.

Figure 6.20 Probability distribution of Atadei geothermal project's earnings before debt service 2019



6.3.3.4 Debt Service

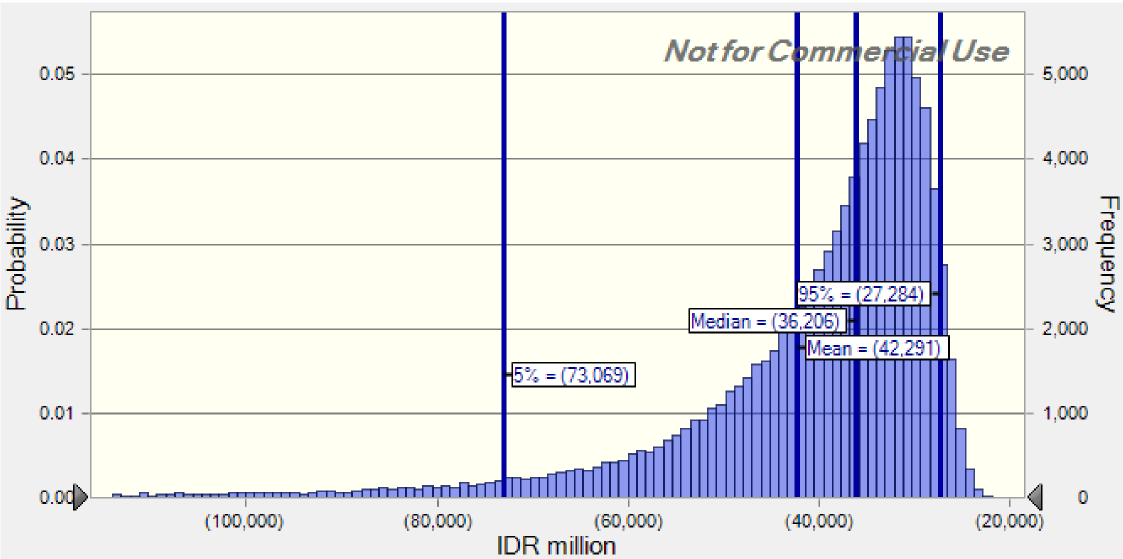
The project apparently will not generate profit, but it still has to meet its financial obligation by servicing its debt for around IDR (32) billion (base case value). The maximum debt payment will be more than IDR 3 trillion (see Table 6.20).

Table 6.20 Atadei geothermal project's debt service 2019 in IDR million.

Statistics	Forecast values
Trials	100,000
Base Case	(31,807)
Mean	(42,291)
Median	(36,206)
Standard Deviation	26,733
Skewness	(23.35)
Kurtosis	1,820.09
Coefficient of Variation	(0.6320)
Minimum	(3,029,134)
Maximum	(20,960)
Mean Std. Error	85

However, Figure 6.21 shows the possibility that the highest debt service amount will happen is near to zero. The probability for debt payment of more than IDR (73) is only 5%. The debt service will be around IDR (36) billion (median value), IDR (42) billion (mean value), or around IDR (30) billion (peak of the probability graph).

Figure 6.21 Probability distribution of Atadei debt service 2019



6.3.3.5 Financial Impact to PLN

The Atadei geothermal project will suffer a deficit of IDR (31) billion (median) as it generates less revenue than its operating cost, excluding interest expenses. As a result, it will be unable to pay its project debt of around IDR (36) billion (see Table 6.11).

Table 6.21 Financial impact of Atadei geothermal project to PLN for 2019 in IDR million

Financial Impact	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
Deficit	(36,129)	(31,231)	(464,191)	(7,820)	(69,063)	(18,687)
Debt Service	(42,291)	(36,206)	(3,029,134)	(20,960)	(73,069)	(27,283)

6.4 Simulation Results

The Ulumbu, Mataloko, and Atadei geothermal projects will suffer deficit for 2019 so these projects will not be able to service their debts. These deficit also require PLN to allocate its profit to pay the operating cost of these projects.

6.4.1 Surplus/(Deficit)

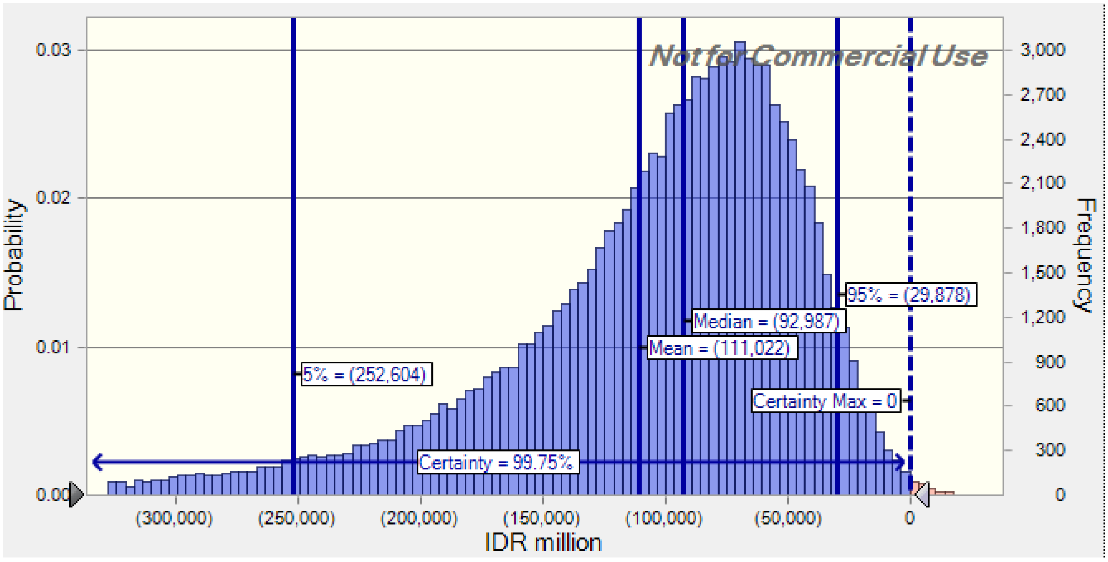
On average, PLN will suffer a deficit of around IDR (84) billion for 2019. This deficit can expand to up to IDR (1.9) trillion. However, there is also a slight chance (0.25%) chance for these geothermal power plant to make a profit of a maximum of IDR 27 billion.

Table 6.22 PLN total surplus/(deficit) from developing geothermal projects for 2019 in IDR million.

Statistics	**Forecast values**
Trials	100,000
Base Case	(83,769)
Mean	(110,998)
Median	(92,748)
Standard Deviation	78,455
Skewness	(2.94)
Kurtosis	23.14
Coefficient of Variation	(0.7068)
Minimum	(1,885,508)
Maximum	27,027
Mean Std. Error	248

Figure 6.23 shows that from developing geothermal power plants, PLN will experience deficit with a 45% chance that it will fall between IDR (99) billion to IDR (30) billion. The average of the total deficit will be around IDR (93) billion. There is a 50% chance that the total deficit will be more than IDR (93) billion.

Figure 6.22 PLN total deficit from developing geothermal projects for 2019 in IDR million



On average all of the geothermal projects contribute almost equally to the total deficit. On median value, the Mataloko project has the lowest deficit, but it has the most extensive possibility range both in 100% certainty and 90%, so the Mataloko project deficit becomes the most uncertain. Furthermore, in total, for 2019, although the deficit can go extensively from a deficit of IDR (1.9) trillion to a surplus of IDR 27 billion, those maximum and minimum numbers will be nearly impossible to happen as with 90%, the deficit will be between IDR (253) billion to IDR (30) billion (see Table 6.3).

Table 6.23 PLN surplus/(deficit) from developing geothermal power plants, for 2019 in IDR million

Geothermal Project	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
Ulubelu	(39,769)	(35,830)	(605,321)	14,869	(87,065)	(4,399)
Mataloko	(35,123)	(26,275)	(815,996)	46,316	(110,420)	(10,911)
Atadei	(36,129)	(31,231)	(464,191)	(7,820)	(69,063)	(18,687)
Total Deficit	(110,998)	(92,748)	(1,885,508)	27,027	(252,604)	(29,878)

6.4.2 Debt Service

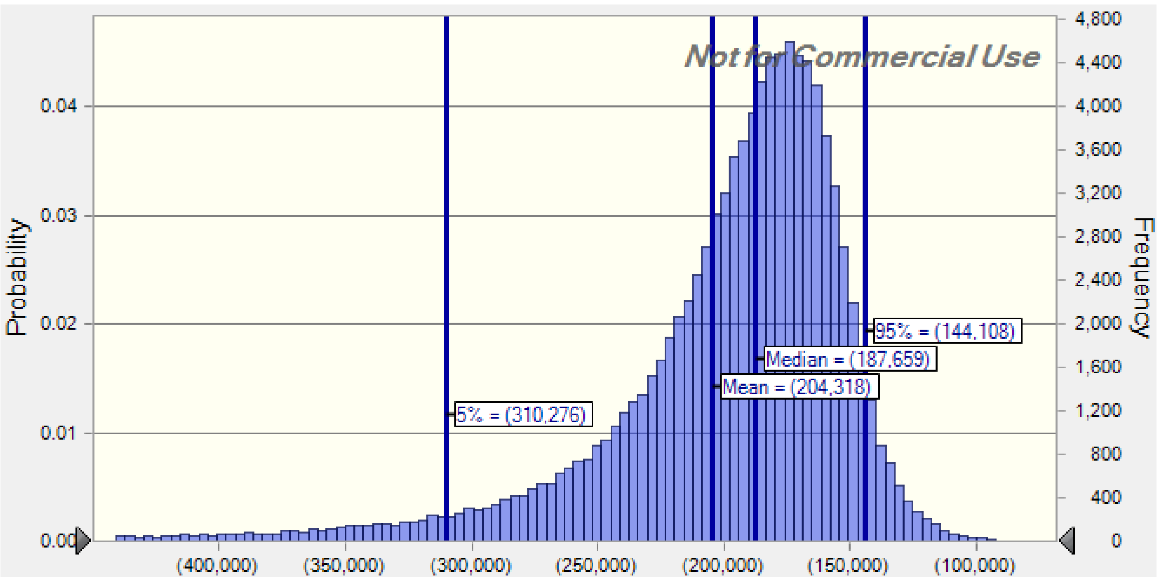
It is estimated that PLN will need to pay project's loans for the Ulumbu, Mataloko, and Atadei geothermal projects of IDR 161 billion (base case). This debt obligation might go up to IDR (3.9) trillion, but it also can go down IDR (82) billion (see Table 6.24).

Table 6.24 PLN total debt service from developing geothermal projects for 2019 in IDR million

Statistics	Forecast values
Trials	100,000
Base Case	(161,207)
Mean	(204,318)
Median	(187,659)
Standard Deviation	80,827
Skewness	(9.88)
Kurtosis	228.64
Coefficient of Variation	(0.3955)
Minimum	(3,921,650)
Maximum	(82,628)
Mean Std. Error	256

Figure 6.23 shows that the probability distribution of the debt service has a long-left tail so that the probability of servicing debt for (3.9) trillion will be nearly zero, even though there is a 95% chance that PLN will pay the project debt no more than IDR 310 billion. The most likely amount of debt repayment for 2019 will be around IDR (180) billion with a 45% chance that the debt service will be between IDR (188) billion to IDR (144) billion.

Figure 6.23 PLN total debt service from developing geothermal projects for 2019 in IDR million



It was assumed that debt financing contributes 70% of the project cost so the bigger the project the bigger also the debt. In this study, the Mataloko 20 MW geothermal project is the biggest PLN geothermal power plant in 2019, so it requires the largest debt payment. Meanwhile, the Atadei 5 MW geothermal is the smallest geothermal project which requires debt service approximately just under 50% of the Mataloko project, so the Atadei project is the most expensive power plant in terms of cost/MW.

Table 6.25 PLN total debt service from developing geothermal projects for 2019 in IDR million

Geothermal Project	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
Ulubelu	(64,169)	(56,153)	(3,088,024)	(12,691)	(110,169)	(37,413)
Mataloko	(97,858)	(85,667)	(3,834,089)	(705)	(168,584)	(55,877)
Atadei	(42,291)	(36,206)	(3,029,134)	(20,960)	(73,069)	(27,283)
Total Debt Service	(204,366)	(187,659)	(3,921,650)	(82,628)	(310,276)	(144,108)

6.5 Chapter Summary

This chapter presented the third and the most complicated simulation model where detailed geothermal costs, which cover the risky geothermal exploration, exploitation, and operation and maintenance, were modelled and simulated to the Ulumbu, Mataloko, and Atadei projects. Debt service for the projects was also simulated which then found that all of these projects will suffer loss, so PLN cannot service the debt from the projects' revenue. Instead, PLN as the project sponsor has to allocate its earning to pay the projects' operating expenses and debt. Based on the median value, PLN has to cover the projected deficit of around IDR (93) billion and cover debt payment for around IDR (188) billion. In the next chapter, this financial impact will be assessed as to whether it will trigger significant fiscal risk or not.

Chapter 7
Research Findings

7.1 Introduction

All of the simulation models in this study have been discussed in the previous chapters. Chapter 4 simulated PLN's Income Statement and found out that before incorporating the geothermal projects, PLN can generate profit for around IDR 7 trillion (median value) for 2018 and 2019. Chapter 5 simulated the financial impact for PLN when IPPs developed geothermal power plants and discovered that PLN would suffer a deficit of around IDR (444) billion and IDR (1) trillion (based on median value) for 2018 and 2019 consecutively. Meanwhile, Chapter 6 investigated the financial impact of PLN when it develops geothermal power plants and found out that from this business PLN will suffer another deficit from operational expenses and debt payment.

This chapter will summarise and compare all findings from Chapter 4, 5, and 6 to assess fiscal risk for 2018 and 2019.

7.2 Fiscal Risks

Budget cycle in Indonesia takes one year from January to December, so any fiscal risk spending to be allocated every year. Therefore, the fiscal risk assessment will be conducted separately for 2018 and 2019. Fiscal risk will be arising when PLN cannot take over the projects' deficit and debt service.

7.2.1 PLN Profit/(Loss)

In 2018, PLN there is no PLN's power plant operating, so it only exposed to Business Viability Guarantee, guarantee given to IPPs because PLN purchases their electricity. PLN then sell this electricity to its customers. However, simulation in Chapter 4 found that PLN will do loss selling, selling, as the project will result in a deficit, PLN suffer a deficit as it pays IPPs more than its customer's electricity payment. For the following year, a deficit from purchasing IPPs' electricity and deficit from developing geothermal power plant will be accounted for.

On 2018, PLN will get a net income of around IDR 7 trillion while it has to tackle a deficit of around IDR (444) billion (median value). Table 7.3 compare PLN net income and project' surplus/(deficit). At a glance, there will be no government guarantee exposure since the figure in PLN net income is much greater than the project surplus/(deficit) but both PLN net income and the surplus/(deficit) are not certain. There is also chance that PLN bet income will be negative. In this case, the government should call a Business Viability Guarantee which is the same as the projected deficit from purchasing IPP electricity.

Table 7.1 PLN Net Income and Surplus/(Loss) from Geothermal Projects for 2018 in IDR billion

Description	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
PLN Net Income	3,496	7,015	(247,936)	158,542	(54,601)	49,657
Project Surplus/(Deficit) from purchasing IPP Electricity	(601)	(444)	(8,992)	94	(1,650)	(75)

For the following year, the deficit will grow faster the PLN net income and loans start to be repaid. Both mean and median value of PLN net income is much higher than the sum of the deficits and debt service. However, there is also a chance of the net income being negative of PLN net income become lower than the sum of the deficits and debt service which leads to an exposure of Business Viability Guarantee and Debt Guarantee. The maximum exposure of Business Viability Guarantee is same with the maximum possible value projects' deficit from purchasing IPP electricity, and the maximum exposure of Debt Guarantee will be the same as the debt service (see Table 7.2).

Table 7.2 PLN Net Income, Surplus/(Loss), and Debt Service from Geothermal Projects for 2019 in IDR billion

Description	Mean	Median	100% certainty		90% certainty	
			Minimum	Maximum	Minimum	Maximum
PLN Net Income	3,621	7,124	(250,012)	167,879	(57,835)	53,116
Project Surplus/(Deficit) from purchasing IPP Electricity	(1,162)	(1,006)	(10,271)	94	(2,479)	(1,006)
Project Surplus/(Deficit) from purchasing IPP Electricity	(111)	(93)	(1,886)	27	(253)	(30)
Debt Service	(204)	(188)	(3,922)	(83)	(310)	(144)

In this study, the government guarantee will be called if:

a. There is no available PLN net income to tackle the power plants' deficit,
b. There is some available PLN net income but it less than the total power plants' deficit.

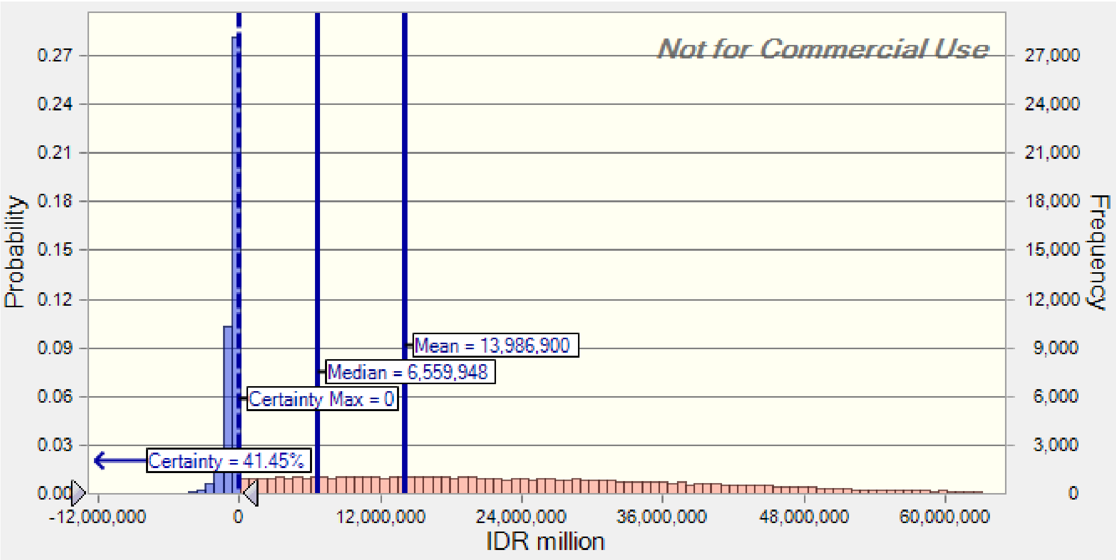
After 100,000 trials it is found that the base case, mean, and median figures show positive values, so it is likely that there will be no fiscal risk from the government guarantees. The base case scenario predicts that instead of calling a fiscal risk, PLN will have a net income of more than IDR 9 trillion (see Table 7.3).

Table 7.3 PLN Net Income/(fiscal risk) after Purchasing Electricity from IPP and Developing Geothermal Power Plant for 2018 and 2019 in IDR million

Statistics	Forecast values	
	2018	2019
Trials	100,000	100,000
Base Case	9,195,415	9,032,524
Mean	13,986,900	14,140,130
Median	6,559,948	5,934,205
Standard Deviation	17,559,913	18,881,907
Skewness	1.11	1.15
Kurtosis	3.51	3.73
Coefficient of Variation	1.26	1.34
Minimum	(11,026,311)	(16,605,640)
Maximum	178,694,714	187,521,239
Mean Std. Error	55,529	59,710

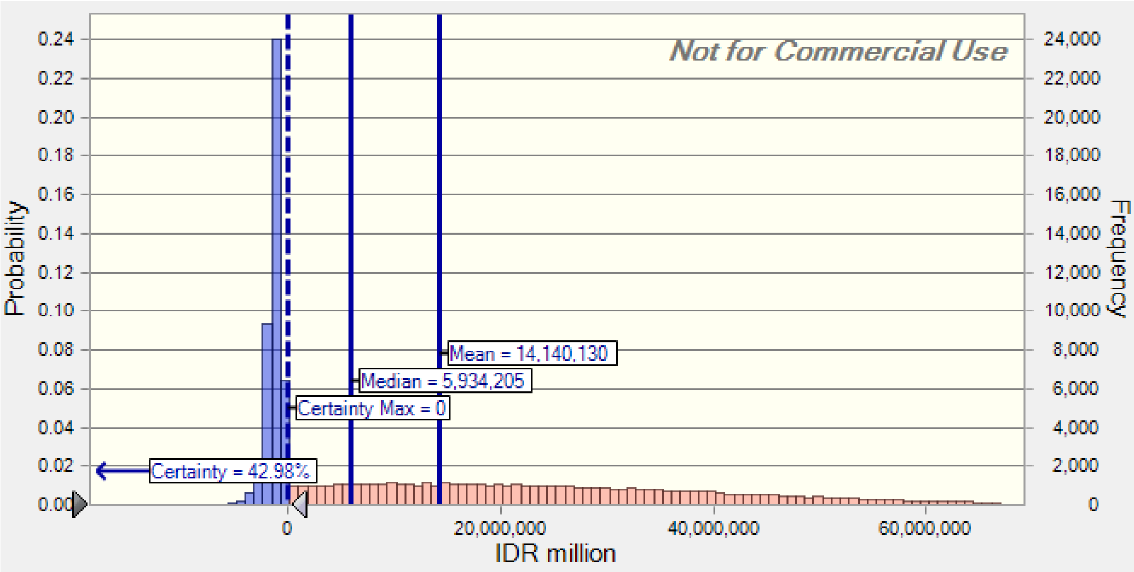
There is just under 60% chance that PLN will make a profit after purchasing electricity from the IPPs (see Figure 7.1) for a maximum of IDR 197 trillion for 2018. However, there is 41.45% chance that the net income will be less than 0 or less than the PLN financial obligation to IPPs for purchasing electricity with a minimum value of IDR (11.0) trillion. In this condition, the government has to take over the PLN obligation and guarantee payment will be paid.

Figure 7.1 Probability distribution of PLN Net Income/(fiscal risk) after Purchasing Electricity from IPP for 2018 in IDR million



The probability of guarantee payment for the following year will increase slightly to 42.98 % with a minimum amount of IDR (16.6) trillion. This also indicated that there would be 57.02% chance of PLN for making a profit with 50% change that the profit will be more than IDR 6.6 trillion (see Figure 7.2).

Figure 7.2 Probability distribution of PLN Net Income/(fiscal risk) after Purchasing Electricity from IPP and Debt Service for 2019 in IDR million



7.2.2 Level of fiscal risk

A fiscal risk is a combination of a fiscal impact and its probability. For 2018, there is an up to IDR (11,026,311) million fiscal impact with a probability of 41.45% which make up of an IDR (4,570,406) million of fiscal risk. Meanwhile, for the following year, the maximum fiscal risk will be IDR (16,605,640) million with 42.98% chance that lead to of an IDR (7,137,104) million. However, these fiscal risks from the government guarantee payment for 2018 and 2019, will under 0.5% of the predicted Indonesian GDP. As IMF and World Bank categorised an impact of below 0.5% as a low risk, so the fiscal risk from the government guarantee for 2018 and 2019 will be as low risk (see Table 7.4).

Table 7.4 Risk rating of the maximum possible government guarantee exposures on geothermal projects for 2018 and 2019 in IDR million

	Government guarantee exposure	Projected GDP in the current price	Fiscal impact thresholds		Risk Rating
			0.5% of GDP	1% of GDP	
2018	4,570,406	15,127,885,438	75,639,427	151,278,854	Low
2019	7,137,104	16,692,954,557	83,464,773	166,929,546	Low

On the other hand, to execute these guarantee payment, the government need to have a cash balance available more than the guaranteed amount. If the government does not have the money, it will lead to other risks including reputation risk and liquidity risk. As for the past 8 years, the Indonesian government is holding cash more than IDR 80 trillion, it is likely that the government has sufficient fund to pay the government guarantee exposures for 2018 and 2019.

7.3 Finding on how to minimise fiscal risks

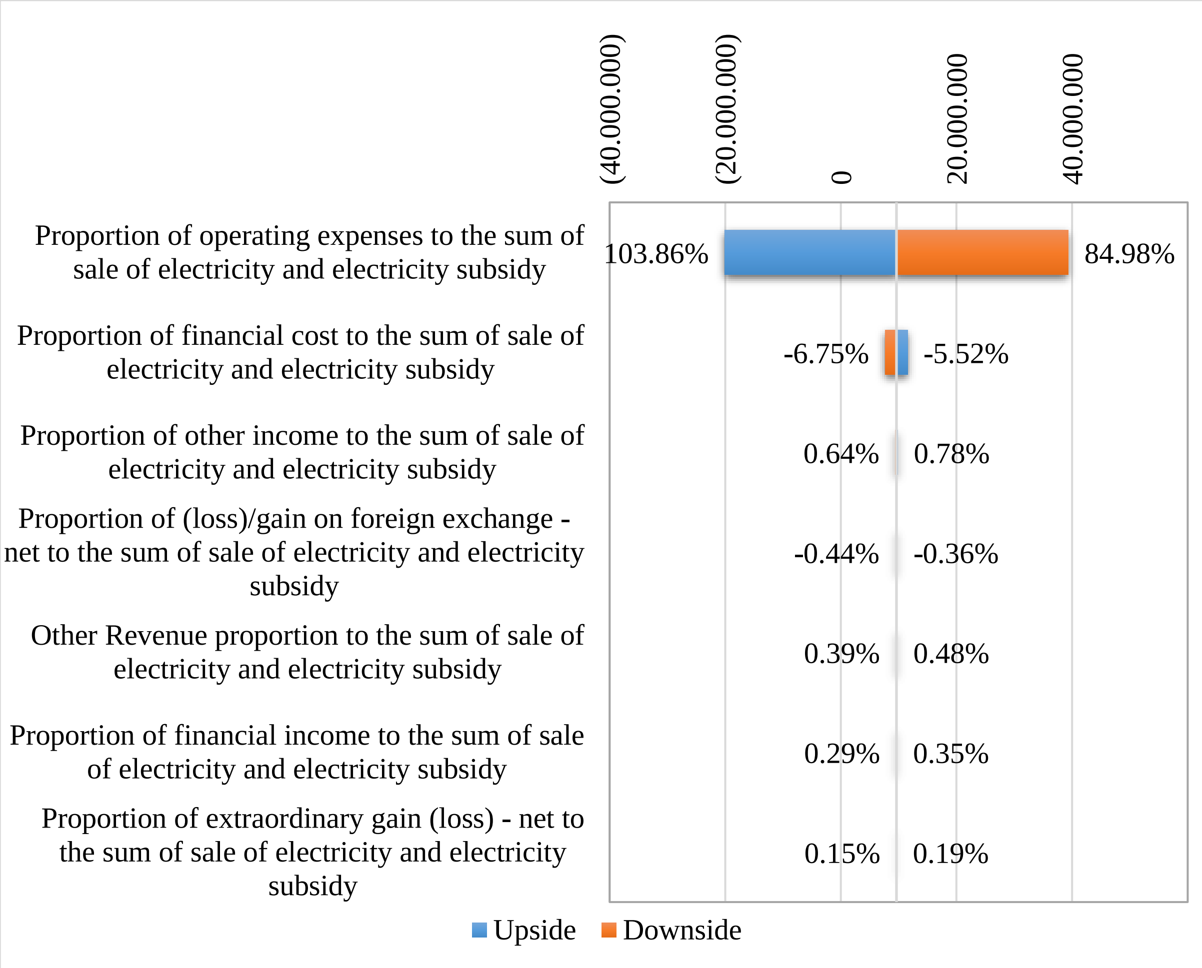
There are several factors determining fiscal risk exposure including PLN net income before additional geothermal projects, surplus/(deficit) from purchasing electricity from IPPs, surplus/(deficit) from developing geothermal power plants, and debt service.

7.3.1 PLN net income before additional geothermal projects

A healthy financial condition of PLN can deter, government guarantee exposure. PLN financial condition is susceptible to PLN net income. The most significant cost driver for PLN is operating income, followed by financial cost, and other income (see Figure 7.3). Therefore, to minimise fiscal risk, PLN should reduce its operating income by doing more efficiency. The main operating cost of PLN fuel and lubricant, a high price of fuel will increase PLN operating cost. A fixed contract to energy procurement contractor might help solve this issue.

The guarantee exposure also because of the cost of electricity from geothermal power plants generally higher than the retail price of the electricity. Therefore, to minimise the fiscal risks, either reducing the cost or increasing the retail price or both.

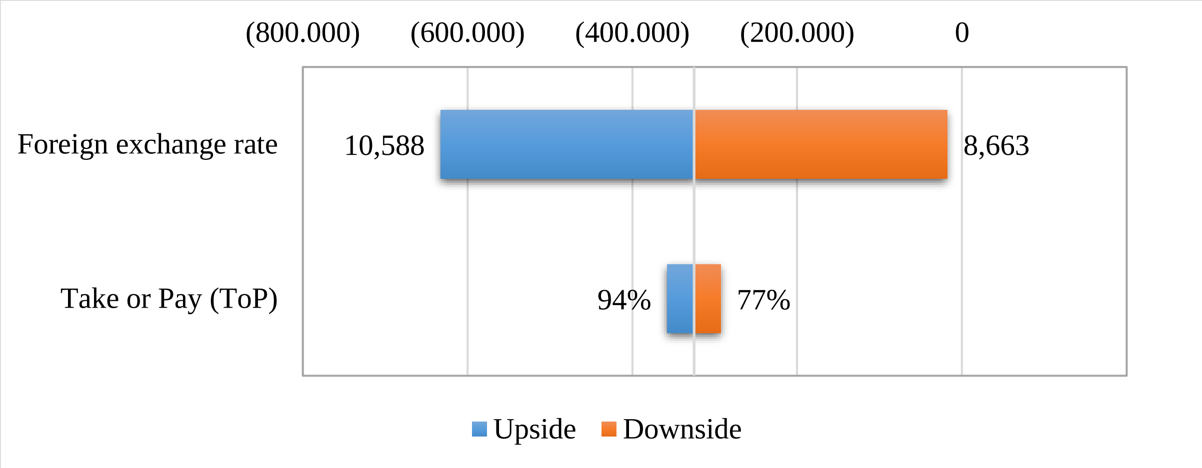
Figure 7.3 Tornado chart of PLN net income before additional geothermal projects for 2018 in IDR million



7.3.2 Surplus/(deficit) from purchasing electricity from IPPs

PLN buy power from IPPs in USD currency but sell it in IDR, so PLN income will be very sensitive to the foreign exchange rate. An appreciation of IDR will favour to PLN and vice versa. Therefore, to minimise the risk, the government should stabilize the exchange rate or denominate the electricity purchase price into IDR. PLN can do a currency hedging to make the foreign exchange rate more certain. Take-or-pay (TOP) also impact to the surplus/(deficit), as the geothermal price paid by PLN is higher than the average electricity retail price, more percentage in TOP will lead to a more profound deficit.

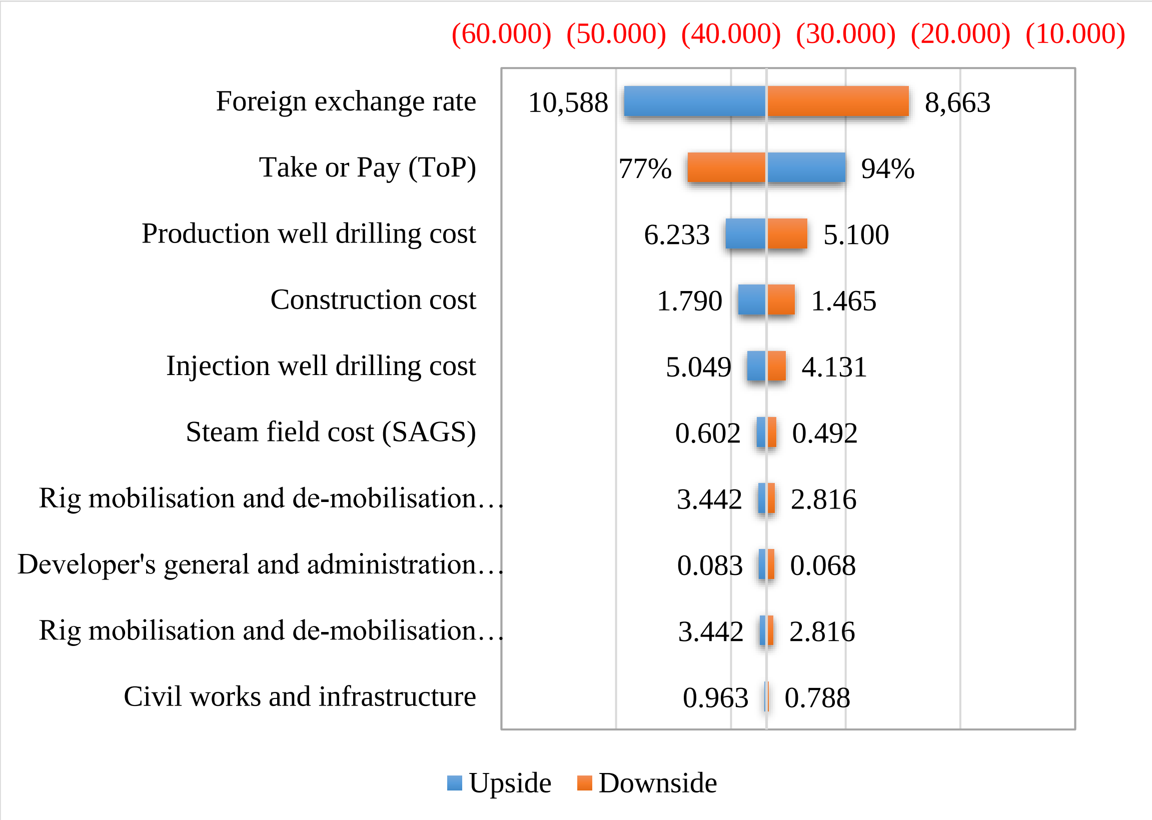
Figure 7.4 Tornado chart of Sarulla project cost for 2018 in IDR million



7.3.3 Surplus/(deficit) from developing geothermal power plants

The foreign exchange rate also the most sensitive cost factor when PLN develop geothermal power plants. It is because most capital and operating expenses are denominated in USD. Other costs impacting the geothermal power plants cost are well drilling and construction costs. Therefore, to minimise deficit and fiscal risk, PLN should use the Geothermal Fund facility (GFF) so that the well drilling cost will be more predictable and the well drilling cost can be shared between PLN and the government. As geothermal projects involving many uncertainties including well capacity, capital expenditures, and operating expenditures, the variation of these costs can make the total generation cost hard to measure, so to minimise the risk the cost should be made more specific. A fixed contract to energy procurement contractor might help lessen risk of the construction cost escalation.

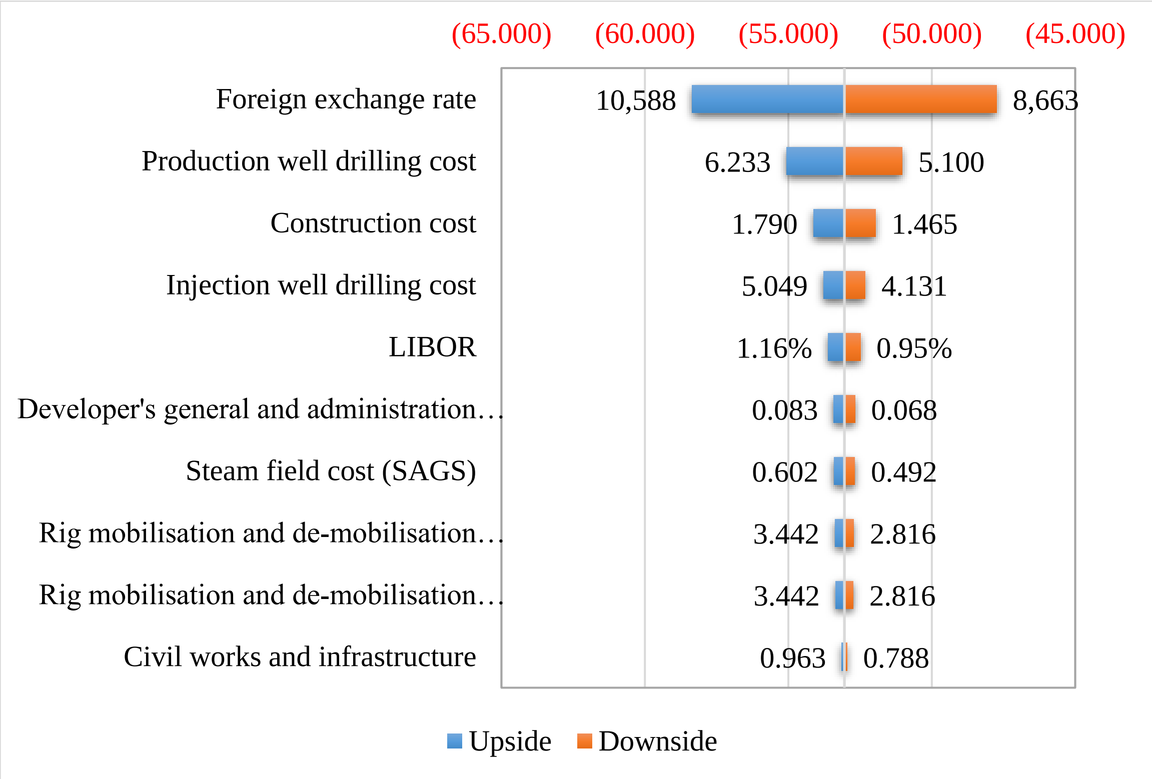
Figure 7.5 Tornado chart of Ulumbu project cost for 2018 in IDR million



7.3.4 Debt service

Regarding debt service, it depends on the debt amount. Meanwhile, debt amount depends on the project cost. Therefore, the most sensitive cost factors of debt service are similar to those factors for surplus/(deficit) when PLN develop geothermal power plants. The only difference is that debt service payment also sensitive to the LIBOR (see Figure 7.6). However, LIBOR has a smaller impact than foreign exchange, construction cost, and well drilling fluctuation.

Figure 7.6 Tornado chart of Ulumbu project debt service for 2018 in IDR million



7.4 Discussions

The simulation resulting that it is likely that there will be no fiscal risk from Business Viability Guarantee and Debt Guarantee for 2018 and 2019 so the government does not have to allocate the guarantee payment. However, the Indonesian budget might be exposed to the Business Viability and Debt Guarantees around IDR 4.6 trillion and 7.1 billion for 2018 and 2019 consecutively. Based on the IMF and World Bank criteria, these fiscal impacts are categorised as low risk. For 2018, the Indonesian budget also has allocated IDR 973 billion for other government guarantees. If this guarantee allocation is added to the Business Viability Guarantee and Debt Guarantee exposure, it will result in the low-risk criteria as it will still less than 0.5% of the Indonesian GDP (IDR 75.6 trillion) (see Table 7.4). The government guarantee is paid in cash, the Indonesian average cash balance of more than IDR 80 trillion (see Figure 3.2) indicates that the Indonesian government will be able to tackle this risk.

The estimation of fiscal exposures using a Monte Carlo resulting in probabilistic figures providing tails. These tails show the maximum exposure of the fiscal risks but with the lowest probabilities. The maximum guarantee exposure for 2018 is IDR (11.0) trillion and for 2019 IDR (16.6) trillion. As these figures are below the 0.5% GDP, even the maximum exposures are categorised as low risk.

This fiscal risk can be reduced by reducing the uncertainty. There are many uncertainties in geothermal projects including well capacity, capital expenditures, and operating expenditures. The government has established Geothermal Fund Facility (GFF) to ensure the geothermal well capacity. The effectiveness of this facility cannot be measured in this study as none of the geothermal projects examined in this thesis using the facility. Meanwhile, fixed contracts might able to change the probability distribution of the costs into deterministic figures. However, as the risks are transferred to contractors, they may charge risk premiums.

Increasing retail electricity price is not a popular decision, but it might help to minimise the fiscal risks. If PLN receives electricity revenues more than its payments to IPPs, the Business Viability Guarantees will not be called. As for Debt Guarantees, these apply when PLN build its owned power plant. As this study found that PLN builds three small geothermal power plants that have high unit costs, so to reduce fiscal risks PLN can choose not to make the power plant and build more efficient power plants. However, this decision might not in line with the government commitment to reducing GHG.

7.5 Chapter Summary

This chapter answers research questions in Chapter 1 based research framework explained in Chapter 3 and simulation results in Chapter 4, 5, and 6. The fiscal risk from Business Viability Guarantee and Debt guarantee are called when there is no available PLN net income to tackle the power plants' deficit (PLN net income before the additional geothermal project is zero or less), or there is PLN net income to tackle the deficit, but the amount is not sufficient. It is likely that the government guarantee will not be called, but there is around 40% chance that the government guarantee will be called for 2018 and 2019. These guarantee payment will be in a low-risk range but there several measures can be taken to minimise the risk including stabilising foreign exchange rate, reduce the drilling costs, or increase the retail electricity price. In the next chapter, summary, conclusion, and recommendation for this thesis will be provided. It will review the research question, findings, policy implication and recommendation as well as contribution to this study and suggestion for future research.

Chapter 8
Summary, Conclusion and Recommendation

8.1 Introduction

Chapter 7 summarise result of all simulation models. It was found that it is likely that no fiscal risk exposure for government guarantees for 2018 and 2019 but there is around 40% chance of the guarantee exposures for those years. In this chapter, problem statement and methodology will be reviewed along with a summary of the findings to find policy implication and formulate recommendations. The contribution of this study will be highlighted along with the limitation of the study. In the end, a suggestion for the future research will be given.

8.2 A Review of the Problem Statement and Methodology

Despite the importance of electricity to enhance economic growth and government revenue, alleviate poverty, and provide social benefits, many people in Indonesia do not have yet access to electricity. The government planned to develop more power plants to increase the electricity supply so that almost all people in Indonesia would have this access by 2025. In Indonesia, there is only one electricity utility company, a state-owned company named PLN. This company has been building power plants with internal financing, lending from creditors, and government capital injection. However, these internal and government sources are limited so the government provides sector participation.

There are two ways the private sector can participate in power plant development. First, a private company can become an investor who builds a power plant and sells the generated electricity to PLN, who then retails this electricity to its consumers. Second, the investors provide PLN with project loans so that PLN has adequate financing to build power plants. The government has been giving government support for those investors, including Business Viability Guarantees for the first type of investors and Debt Guarantees for the second type of investors. However, these guarantee policies can put the government at fiscal risk, so these guarantees need to be assessed and measured to ensure that proper risk mitigation plans have been conducted.

Currently, most power plants in Indonesia use fossil fuel as their primary energy, mostly oil and coal-based. On the other hand, renewable energy potential in Indonesia is high and mostly underdeveloped, particularly geothermal. Moreover, Indonesia has committed to reducing Green House Gas (GHG) emissions, so the government chose to develop more renewable energy power plants, especially geothermal.

The government incentives for the geothermal power plant development might be creating fiscal risk, so to ensure that this risk will be manageable this research and thesis aimed:

a. To quantify fiscal risks from government guarantees on renewable energy development;
b. To estimate the probabilities and consequences of the fiscal risks (level of the fiscal risks); and
c. To determine policy levels that would minimise fiscal risk.

In identifying fiscal risk from renewable energy development, several kinds of literature regarding these topics were examined. The results were then incorporated into the financial models which applied a Monte Carlo Simulation with Crystal Ball software to assess the fiscal risks. To understand fiscal risk from government guarantees on geothermal projects, each of the geothermal projects planned to operate in 2018 and 2019 commercially was modelled to resemble real geothermal projects. There were two types of financial model, first for Business Viability Guarantee recipients and second for Debt Guarantee recipients. The first model compares retail electricity revenue with its electricity purchased cost. If this results in a deficit, PLN has to pay the deficits to IPPs. Meanwhile, the second model compares the retail electricity revenue with its generation cost. If it results in deficits, the projects cannot fulfil their debt obligations, so PLN has to service the debts. When PLN cannot tackle projects' payments to IPPs for purchasing electricity and to lenders to service the projects' debts, the government guarantee is likely to occur.

8.3 Summary of the Results

It was found that fiscal risk from the government guarantee results from contingent liabilities which can become liabilities when the guaranteed event happens, so the fiscal risk needs to be assessed and managed to ensure that the government will be able to mitigate the risks.

After 100,000 iterations with the Monte Carlo simulation, it was found that it is likely there will be no government guarantee for geothermal projects for 2018 and 2019 so the government does not have to allocate the guarantee payment. However, there is around 40% chance that there will be an exposure of up to IDR (11.0) trillion and IDR (16.6) trillion for 2018 and 2019 respectively. Therefore, the fiscal risk will be IDR (4.6) trillion and IDR (7.1) trillion for 2018 and 2019 consecutively. These guarantee exposures are rated as low risk as they are below the threshold value of 0.5% of GDP. During 2018 and 2019, it is also expected that the government will have a sufficient cash balance to pay the maximum possible guarantee amounts.

On the other hand, this fiscal risk can also be minimised by stabilizing the foreign exchange rate, increasing the electricity price or decreasing the geothermal generating cost, especially the well drilling cost. Decreasing the generation costs can be done by providing more government facilities, and reducing the uncertainty factor in the costs by signing a fixed contract with third parties.

8.4 Policy Implications and Recommendations

As it is predicted that there will be no government guarantee exposure for geothermal projects in 2018 and 2019, the government need not allocate the guarantee expenditures in the national budget. The government can allocate the amount to other important expenditure. If the rare events happen, the government can use its idle cash balance to pay.

To minimise the rare events, the government can reduce their likelihood and impact. This can be done by reducing the uncertainty factors. On the revenue side, there is an uncertainty of the future retail electricity price so the government can establish an estimated future price. On the cost side, the government can provide more incentives including tariff and tax facility so that geothermal developers can get a more competitive price.

8.5 Contribution of this Study

At the practical level, this study can be applied for decision making regarding government guarantee in Indonesia. The financial model can be modified to assess fiscal risk from other geothermal projects in Indonesia, so the government guarantee budget is more accountable. The financial models also provide explanations of variable relations from geothermal technical variables, financial variables, and fiscal variables.

In terms of academic contribution, this study explains the transmission of fiscal risk from government guarantees on geothermal projects in Indonesia. It was found that geothermal projects can increase fiscal risk. This risk can be low, medium or high depending on its fiscal impacts compared to GDP.

8.6 Limitations of the study

This Monte Carlo simulation uses many assumptions to build probability distributions, mainly related to the technical costs, which are based only on a few publications because the author could not find other publications. If these assumptions are wrong, the output will be misleading. However, these assumptions are also used by the Indonesian government, World Bank, Asian Development Bank, and International Monetary Fund.

This study only assesses fiscal risks from geothermal power plants: at the same time, PLN and IPPs are developing many other types of power plants. If all of the deficit from all power plants are totalled, the government my faced a significant amount of guarantee exposure. The projected PLN financial condition was also made without calculating profit from other additional types of power plants.

This study models geothermal power plant cost based on its Region and size, so two different geothermal power plants in the same Region will have a same cost if they have the same size. However, in reality, the cost might be the difference as each location has its specific challenges. For example, geothermal in Java and Sumatera are in same Region 1 but, Java and Sumatera have difference infrastructures such as road and bridges capacities. When PLN or IPP mobilise rig, they need a reliable road and bridges which are available in Java but not always available in Sumatera.

8.7 Suggestions for Future Research

All assumptions in these models need to be check and updated with the most recent and comprehensive studies as there are many uncertainties involved. The most recent detail geothermal financial data quoted in this study is from 2009 and the good success factor, a significant cost driver, also from 2008 data, so the data need to be updated. Moreover, to understand better the fiscal risk from a government guarantee, all power plants' surpluses and deficits need to be assessed in the same year. Moreover, the geothermal cost will be more accurate if it calculated based on geothermal site specifics.

8.8 Chapter Summary

This last chapter summaries all chapters in this research. It is found that there is a fiscal risk in the government expenditure due to the government support programs for the renewable energy projects, especially geothermal projects. The probability of the risk will be around 40% with predicted impacts of a maximum of IDR (11) trillion and IDR (16) trillion for 2018 and 2019 consecutively. Therefore, the fiscal risk will be IDR (4.6) trillion and IDR (7.1) trillion for 2018 and 2019 respectively. These exposures are defined as low risk but it still can be minimise by stabilising foreign exchange rate, increasing the electricity price or minimising the geothermal generating cost, especially the well drilling cost.

This study has several limitation because of its underlying assumption based only on a few publications. If these assumptions are wrong, the output will be misleading. However, these assumptions are no longer applied, the result can be misleading. Simulation models in this study also based on geothermal Region and size to simplify the geothermal cost calculation which might make it less accurate.

References

Acebes, F, Pajares, J, Galán, JM & López-Paredes, A 2014, 'A new approach for project control under uncertainty. Going back to the basics', *International Journal of Project Management*, vol. 32, no. 3, pp. 423-34.

Akar, S & Young, KR 2015, 'Assessment of new approaches in geothermal exploration decision making', paper presented to The fourtieth workshop on geothermal reservoir engineering, California, January 26-28, 2015.

Al-Mulali, U & Sab, CNBC 2012, 'The impact of energy consumption and CO 2 emission on the economic growth and financial development in the Sub Saharan African countries', *Energy*, vol. 39, no. 1, pp. 180-6.

Apergis, N & Payne, JE 2011, 'A dynamic panel study of economic development and the electricity consumption-growth nexus', *Energy Economics*, vol. 33, no. 5, pp. 770-81.

Asia Today International 2013, 'US $200 bill. in projects on offer in Indonesia', *Asia Today International*, vol. 31, no. 2, April 2013, <https://search.informit.com.au/documentSummary;dn=298390957743691;res=IELBUS>.

Asian Development Bank & The World Bank 2015, *Unlocking Indonesia's geothermal potential*, Mandaluyong City.

Atmo, G & Duffield, C 2015, 'Attaining value from private investment in power generation projects in Indonesia', *Journal of Sustainable Infrastructure Development*.

Australian Government 2008, *National Public Private Partnership Guidelines O njverview*, Commonwealth of Australia, Canberra.

Aven, T 2011, 'On the new ISO guide on risk management terminology', *Reliability Engineering & System Safety*, vol. 96, no. 7, pp. 719-26.

Bachmair, FF 2016, *Contingent liabilities risk management: a credit risk analysis framework for sovereign guarantees and on-lending? country experiences from Colombia, Indonesia, Sweden, and Turkey*, World Bank Policy Research Working Paper WPS7538, The World Bank, Washington.

Badu, E, Owusu-Manu, D-G, Edwards, DJ & Holt, GD 2013, 'Analysis of strategic issues underpinning the innovative financing of infrastructure within developing countries', *Journal of Construction Engineering & Management*, vol. 139, no. 6, pp. 726-37.

Baldacci, E, Gupta, S & Mati, A 2011, 'Political and fiscal risk determinants of sovereign spreads in emerging markets', *Review of Development Economics*, vol. 15, no. 2, pp. 251-63.

Ball, R, Heafey, M & King, D 2007, 'The private finance initiative in the UK: a value for money and economic analysis', *Public Management Review*, vol. 9, no. 2, pp. 289-310.

Bank of Indonesia 2017, *Foreign exchange rates*, Bank of Indonesia, viewed 1 February 2017, <http://www.bi.go.id/en/moneter/informasi-kurs/transaksi-bi/Default.aspx>.

Bergman, N & Foxon, T 2018, *Reorienting Finance Towards Energy Efficiency: The Case of UK Housing*, SPRU-Science and Technology Policy Research, University of Sussex.

Bhattacharya, A & Kojima, S 2012, 'Power sector investment risk and renewable energy: a Japanese case study using portfolio risk optimization method', *Energy Policy*, vol. 40, pp. 69-80.

Blanc-Brude, F, Chen, G & Whittaker, T 2016, *Towards better infrastructure investment products? a survey of investor's perceptions and expectations from investing in infrastructure*, the EDHEC Infrastructure Institute-Singapore and Global Infrastructure Hub, Singapore.

Bordo, MD & Haubrich, JG 2017, 'Deep recessions, fast recoveries, and financial crises: evidence from the American record', *Economic Inquiry*, vol. 55, no. 1, pp. 527-41.

Brandimarte, P 2014, *Handbook in Monte Carlo Simulation: Applications in Financial Engineering, Risk Management, and Economics*, John Wiley & Sons.

Brixi, HP & Mody, A 2002, 'Dealing with government fiscal risk: an overview', in HP Brixi & A Schick (eds), *Government at risk: contingent liabilities and fiscal risk*, The World Bank and Oxford University Press, New York, pp. 21-58.

Brixi, HP & Schick, A 2002, *Government at risk: contingent liabilities and fiscal risk*, World Bank Publications, Washington, DC.

Broadbent, J, Gill, J & Laughlin, R 2008, 'Identifying and controlling risk: the problem of uncertainty in the private finance initiative in the UK's national health service', *Critical Perspectives on Accounting*, vol. 19, no. 1, pp. 40-78.

Canuto, O, Dos Santos, PFP & de Sá Porto, PC 2012, 'Macroeconomics and sovereign risk ratings', *Journal of International Commerce, Economics and Policy*, vol. 3, no. 02, p. 1250011.

Carbonara, N, Costantino, N & Pellegrino, R 2014, 'Revenue guarantee in public-private partnerships: a fair risk allocation model', *Construction Management & Economics*, vol. 32, no. 4, pp. 403-15.

Castle Rock Consulting 2010, *Phase 1 report: review & analysis of prevailing geothermal policies, regulations and costs*, Ministry of Energy and Mineral Resources Indonesia, Jakarta.

Cebotari, A, Davis, J, Lusinyan, L, Mati, A, Mauro, P, Petrie, M & Velloso, R 2009, *Fiscal risks: sources, disclosure, and management*, International Monetary Fund, Washington, DC.

Center for Data and Information Technology 2015, *Handbook of energy & economic statistics of Indonesia*, Ministry of Energy and Mineral Resources Republic of Indonesia, Jakarta.

—— 2016, *Handbook of energy & economic statistics of Indonesia*, Ministry of Energy and Mineral Resources Republic of Indonesia, Jakarta.

Centre for Strategic Studies 2009, *Land capping policy as financing instrument for toll road land aquisition*, Ministry of Public Work Indonesia, viewed 12 September 2014, <http://www.pu.go.id/isustrategis/view/25>.

Chan, APC, Lam, PTI, Chan, DWM, Cheung, E & Ke, Y 2010, 'Critical success factors for PPPs in infrastructure developments: Chinese perspective', *Journal of Construction Engineering and Management*, vol. 136, no. 5, pp. 484-94.

Chandra, P 2014, *Fundamentals of financial management*, Tata McGraw-Hill Education.

Charnes, J 2007, *Financial modeling with Crystal Ball and Excel*, Wiley Finance, John Wiley & Sons, Inc., New Jersey.

Cheah, CY & Liu, J 2006, 'Valuing governmental support in infrastructure projects as real options using Monte Carlo simulation', *Construction Management and Economics*, vol. 24, no. 5, pp. 545-54.

Chen, S-T, Kuo, H-I & Chen, C-C 2007, 'The relationship between GDP and electricity consumption in 10 Asian countries', *Energy Policy*, vol. 35, no. 4, pp. 2611-21.

Chen, Y-c & Lee, D 2013, *What makes a commodity currency?*, unpublished.

Committee, D 2017, *Maximising Finance for Development: Leveraging the Private Sector for Growth and Sustainable Development*, World bank and IMF, Washington D.C.

Coordinating Ministry of Economic Affairs 2010, *Public private partnership (PPP): Investor's Guide*, Republic of Indonesia, Jakarta.

Corsetti, G, Kuester, K, Meier, A & Müller, GJ 2013, 'Sovereign risk, fiscal policy, and macroeconomic stability', *The Economic Journal*, vol. 123, no. 566, pp. F99-F132.

Cui, T 2010, 'Bayesian calibration of geothermal reservoir models via Markov Chain Monte Carlo', Doctor of Philosophy thesis, The University of Auckland.

Deloitte 2008, *Geothermal risk mitigation strategies report*.

Deputy Assistant for Climate Change Impact Control Ministry of Environment Indonesia 2006, *Current Status of CDM Implementation in Indonesia*, The World Bank, Jakarta.

Dickson, MH & Fanelli, M 2004, *What is Geothermal Energy?*, International Geothermal Association, viewed 28 November 2017, <https://www.geothermal-energy.org/geothermal_energy/what_is_geothermal_energy.html>.

Dickson, MH & Fanelli, M 2013, 'Geothermal background', in MH Dickson & M Fanelli (eds), *Geothermal energy: utilization and technology*, United Nations Educational, Scientific and Cultural Organization, Bangalore.

Directorate General of Mineral and Coal 2016, *Indonesia Mineral and Coal Information 2015*, 28 vols., Kementerian Energi dan Sumber Daya Mineral, Jakarta.

Directorate General of New Renewable Energy and Energy Conservation 2016, *Statistic book of new, renewable energy and energy conservation*, Directoral General of New, Renewable Energy and Energy Conservation, Jakarta.

Directorate General of Oil and Gas 2016, *Statistics Oil and Gas 2015*, 28 vols., Kementerian Energi dan Sumber Daya Mineral, Jakarta.

Direktorat Jenderal Energi Baru Terbarukan dan Koservasi Energi 2015, *Statistik EBTKE 2015 (Statistic book of new, renewable energy and energy conservation 2015)*, Kementerian Energi dan Sumber Daya Mineral, Jakarta.

Direktorat Jenderal Ketenagalistrikan 2015, *Statistik ketenagalistrikan 2014 (Electricity statistics 2014)*, 28 vols., Kementerian Energi dan Sumber Daya Mineral, Jakarta.

—— 2016, *Statistik Ketenagalistrikan 2015 (Electricity statistics 2015)*, 28 vols., Kementerian Energi dan Sumber Daya Mineral, Jakarta.

Doan, P & Menyah, K 2013, 'Impact of irreversibility and uncertainty on the timing of infrastructure projects', *Journal of Construction Engineering & Management*, vol. 139, no. 3, pp. 331-8.

Donovan, C & Nuñez, L 2012, 'Figuring what’s fair: The cost of equity capital for renewable energy in emerging markets', *Energy Policy*, vol. 40, pp. 49-58.

Elliott, G & Timmermann, A 2013, *Handbook of economic forecasting*, Elsevier Science.

Esty, BC 2003, 'The economic motivations for using project finance', *Harvard Business School*, vol. 28.

Esty, BC & Megginson, WL 2000, *Syndicate structure as a response to political risk in the project finance loan market*.

European Commission 2003, *Public finances in EMU — 2003*, vol. 3, European Economy, European Commission, Brussel.

Farid, J 2013, *Model at work: a practitioner's guide to risk management*, 1 edn, Global Financial Market, Palgrave Macmillan, New York.

Ferguson, R, Wilkinson, W & Hill, R 2000, 'Electricity use and economic development', *Energy Policy*, vol. 28, no. 13, pp. 923-34.

Froud, J 2003, 'The private finance initiative: risk, uncertainty and the state', *Accounting, Organizations and Society*, vol. 28, no. 6, pp. 567-89.

Gapen, M, Gray, D, Cheng Hoon, L & Xiao, Y 2008, 'Measuring and analyzing sovereign risk with contingent claims', *IMF Staff Papers*, vol. 55, no. 1, pp. 109-48.

Geothermal Technologies Office 2012, 'What is an enhanced geothermal system (EGS)?', *Energy Efficiency & Renewable Energy*, vol. September.

Ghosh, S 2002, 'Electricity consumption and economic growth in India', *Energy Policy*, vol. 30, no. 2, pp. 125-9.

Graham, JR 2000, 'How big are the tax benefits of debt?', *The Journal of Finance*, vol. 55, no. 5, pp. 1901-41.

Granoff, I, Hogarth, JR & Miller, A 2016, 'Nested barriers to low-carbon infrastructure investment', *Nature Climate Change*, vol. 6, p. 1065.

Green, M 1990, *Indonesia: crisis and transformation, 1965-1968*, Compass Press.

Grimsey, D & Lewis, M 2007, *Public private partnerships: The worldwide revolution in infrastructure provision and project finance*, Edward Elgar Publishing.

Grimsey, D & Lewis, MK 2005, 'Are public private partnerships value for money? evaluating alternative approaches and comparing academic and practitioner views', *Accounting Forum*, vol. 29, no. 4, pp. 345-78.

Gzyl, H & Mayoral, S 2010, 'A method for determining risk aversion functions from uncertain market prices of risk', *Insurance: Mathematics and Economics*, vol. 47, no. 1, pp. 84-9.

Hartono, D, Irawan, T & Komarulzaman, A 2014, *Energy pricing policies in Indonesia: a computable general equilibrium model*, EcoMod.

Hasan, M & Wahjosoedibjo, A 2015, 'Indonesia's geothermal energy development, past and challenges ', paper presented to World Geothermal Congress 2015, Melbourne.

Hasan, MH, Muzammil, WK, Mahlia, TMI, Jannifar, A & Hasanuddin, I 2012, 'A review on the pattern of electricity generation and emission in Indonesia from 1987 to 2009', *Renewable and Sustainable Energy Reviews*, vol. 16, no. 5, pp. 3206-19.

Hemming, R 2006, *Public-private partnerships, government guarantees, and fiscal risk*, International Monetary Fund.

Henckel, T & McKibbin, WJ 2017, 'The economics of infrastructure in a globalized world: Issues, lessons and future challenges', *2017*, vol. 1, no. 2, p. 19.

Hensher, DA, Rose, JM & Greene, WH 2005, *Applied Choice Analysis: A Primer*, Cambridge University Press.

Hill, H 1999, *The Indonesian economy in crisis: causes, consequences and lessons*, Institute of Southeast Asian Studies.

Hochstein, MP & Sudarman, S 2008, 'History of geothermal exploration in Indonesia from 1970 to 2000', *Geothermics*, vol. 37, no. 3, pp. 220-66.

Hopkin, P 2013, *Risk management*, Kogan Page, London.

Huang, Y-H & Wu, J-H 2008, 'A portfolio risk analysis on electricity supply planning', *Energy Policy*, vol. 36, no. 2, pp. 627-41.

IEA 2011, *Geothermal heat and power*, OECD Publishing.

International Energy Agency 2016, *World energy outlook 2016*, International Energy Agency, Paris.

International Finance Corporation 2013, *Success of geothermal wells: a global study*, International Finance Corporation, Washington, DC.

International Monetary Fund 2016, *World Economic Outlook Database*, October 2016 edn, International Monetary Fund,, Washington, D.C., 20 Februari 2017, <http://www.imf.org/external/pubs/ft/weo/2016/02/weodata/index.aspx>.

International Monetary Fund & World Bank Group 2016, *PPP fiscal risk assessment model (PFRAM)*, International Monetary Fund and World Bank Group, Washington.

International Organization for Standardization 2009, *ISO 31000: 2009 Risk management–Principles and guidelines*, Geneva.

IPP Procurement Division PT PLN (Persero) 2013, *Independent power producers business in PT PLN (persero)*, PT PLN (Persero), Jakarta.

Iqbal, F & James, WE 2002, *Deregulation and development in Indonesia*, Praeger.

Irawan, T, Hartono, D, Irawan, F & Yusuf, AA 2012, 'Infrastructure improvement and its impacts on the Indonesian economic performance', *Journal of Indonesian Economy & Business*, vol. 27, no. 3, p. 293.

Irwin, TC 2007, *Government guarantees: allocating and valuing risk in privately financed infrastructure projects*, World Bank, Washington.

Japan International Cooperation Agency, West Japan Engineering Consultants Inc & Ministry of Finance Indonesia 2009, *Study on fiscal and non-fiscal incentives to accelerate private sector geothermal energy development in the Republic of Indonesia*, Ministry of Finance Indonesia, Jakarta.

Kaminskiy, MP 2012, *Reliability Models for Engineers and Scientists*, CRC Press.

Kanagawa, M & Nakata, T 2008, 'Assessment of access to electricity and the socio-economic impacts in rural areas of developing countries', *Energy Policy*, vol. 36, no. 6, pp. 2016-29.

Kanoğlu, M & Çengel, YA 1999, 'Economic evaluation of geothermal power generation, heating, and cooling', *Energy*, vol. 24, no. 6, pp. 501-9.

Karyadi, F & Marseille, O 2010, 'Government guarantees in PPP projects', *International Financial Law Review*, vol. 29, no. 10, pp. 52-4.

Kementerian Energi dan Sumber Daya Mineral 2015, *Rencana Umum Ketenagalistrikan Nasional 2015-2034 (National power development plan 2015-2034)*, Kementerian Energi dan Sumber Daya Mineral, Jakarta.

Kopits, G 2014a, 'Coping with fiscal risk', *OECD Journal on Budgeting*, vol. 14, no. 1, pp. 47-71.

—— 2014b, 'Coping with fiscal risk: Analysis and practice', *OECD Journal on Budgeting*, vol. 14, no. 1, p. 47.

Kroese, DP, Taimre, T & Botev, ZI 2013, *Handbook of Monte Carlo methods*, Wiley.

Kuo, G 2012, 'Geothermal energy', *World Future Review*, vol. 4, no. 1, pp. 5-7.

Kwak, YH & Ingall, L 2007, 'Exploring Monte Carlo simulation applications for project management', *Risk Management*, pp. 44-57.

Lee, CF, Lee, JC & Lee, AC 2000, *Statistics for Business and Financial Economics*, World Scientific.

Lucas, D & McDonald, R 2010, 'Valuing government guarantees: Fannie and Freddie revisited', in *Measuring and Managing Federal Financial Risk*, University of Chicago Press, pp. 131-54.

Manly, BFJ 2008, *Statistics for environmental science and management, second edition*, CRC Press.

Maskin, E & Tirole, J 2008, 'Public–private partnerships and government spending limits', *International Journal of Industrial Organization*, vol. 26, no. 2, pp. 412-20.

Menteri Energi dan Sumber Daya Mineral Indonesia 2014, *Peraturan Menteri Energi dan Sumber Daya Mineral Republik Indonesia nomor 17 tahun 2014 (Minister of energy and mineral resources regulation number 17 the year 2014 regarding geothermal power purchases by PLN)* Jakarta.

—— 2016, *Peraturan menteri energi dan sumber daya mineral Indonesia nomor 28 tentang tarif tenaga listrik yang disediakan oleh PLN (Minister of Energy and Mineral Resources Indonesia regulation number 28 regarding electricity tariff from PLN)*, Jakarta.

Menteri Keuangan Indonesia 2009, *Laporan Keuangan Pemerintah Pusat Tahun 2008 (Central government financial statement for the year of 2008)* Republik Indonesia, Jakarta.

—— 2010a, *Peraturan Menteri Keuangan Nomor 21/PMK.011/2010 tenteng Pemberian Fasilitas Perpajakan dan Kepabeanan untuk Kegiatan Pemanfaatan Sumber Energi Terbarukan (Minister of Finance regulation number 21/PMK.011/2010 on tax and excise facilities for renewable energy utilization)*, Kementerian Keuangan, Jakarta.

—— 2010b, *Peraturan Menteri Keuangan Nomor 260/PMK.011/2010 tentang Petunjuk Pelaksanaan Penjaminan Infrastruktur dalam Proyek Kerjasama Pemerintah dengan Badan Usaha (Minister of Finance Regulation Number 260/PMK.011/2010 on the Implemention Guideline for Infrastructure Guarantees in Public-Private Partnership)*, Kementerian Keuangan Indonesia, Jakarta.

—— 2011a, *Laporan Keuangan Pemerintah Pusat Tahun 2010 (Central government financial statement for the year of 2010)* Republik Indonesia, Jakarta.

—— 2011b, *Peraturan Menteri Keuangan Nomor 139/PMK.011/2011 tentang Tata Cara Pemberian Jaminan Kelayakan Usaha PT Perusahaan Listrik Negara (Persero) untuk Pembangunan Pembangkit Tenaga Listrik dengan Menggunakan Energi Terbarukan, Batubara, dan Gas Yang Dilakukan Melalui Kerja Sama dengan Pengembang Listrik Swasta (Minister of Finance regulation number 139/PMK.011/2011 on procedures on business viability guarantee for renewable energy, coal and gas power plant)*, Ministry of Finance, Jakarta.

—— 2012a, *Peraturan Menteri Keuangan Nomor 03/PMK.011/2012 tentang Tata Cara Pengelolaan dan Pertanggungjawaban Fasilitas Dana Geothermal (Minister of Finance decree number 03/PMK.011/2012 on the governance and accountability of geothermal fund facility)*, Kementerian Keuangan, Jakarta.

—— 2012b, *Peraturan Menteri Keuangan Nomor 143/PMK.011/2013 tentang Panduan Pemberian Dukungan Kelayakan atas Sebagian Biaya Konstruksi pada Proyek Kerja Sama Pemerintah Dengan Badan Usaha dalam Penyediaan Infrastruktur (Minister of Finance Regulation Number 143/PMK.011/2013 Concerning Feasibility Support for Part of Construction Support for PPP Projects)*, Kementerian Keuangan, Jakarta.

—— 2013, *Laporan Keuangan Pemerintah Pusat Tahun 2012 (Central government financial statement for the year of 2012)* Republik Indonesia, Jakarta.

—— 2015a, *Laporan Keuangan Pemerintah Pusat Tahun 2014 (Central government financial statement for the year of 2014)* Republik Indonesia, Jakarta.

—— 2015b, *Peraturan Menteri Keuangan nomor 195 tentang tata cara penghitungan, pengalokasian, pembayaran, dan pertanggungjawaban subsidi listrik (Minister of finance regulation number 195 on calculation, alocation, payment and accountability of electricity subsidy)*, Jakarta.

—— 2016, *Peraturan Menteri Keuangan Nomor 130/PMK.08/2016 tentang Tata Cara Pelaksanaan Pemberian Jaminan Pemerintah untuk Percepatan Pembangunan Infrastruktur Ketenagalistrikan (Minister of Finance regulation number 130 on the implementing guideline of government guarantee to accelerate the development of power infrastructures)*, Kementerian Keuangan, Jakarta.

—— 2017a, *Laporan Keuangan Pemerintah Pusat Tahun 2016 (Central government financial statement for the year of 2016)* Republik Indonesia, Jakarta.

—— 2017b, *Peraturan Menteri Keuangan nomor 44/PMK.02/2017 tentang Tata cara penyediaan, penghitungan, pembayaran, dan pertanggungjawaban subsidi listrik (Ministri of Finance Regulation number 44 on admistration of preparing. calculating, paying, and acoountability of electricity subsidy*.

Michael Regan 2014, *Value for money in project procurement*, Research report for the Asian Development Bank 2013, Faculty of Society and Design Publications, Gold Coast.

Ministry of Environment Indonesia 2010, *Indonesia Second National Communication under the UNFCCC*, Jakarta.

Ministry of National Development Planning / National Development Planning Agency 2015, *Public Private Partnerships Infrastructure Projects Plan in Indonesia 2015*, REpublic of Indoensia, Jakarta.

Molak, V 1996, *Fundamentals of risk analysis and risk management*, CRC-Press.

Morallos, D & Amekudzi, A 2008, 'The state of the practice of value for money analysis in comparing public private partnerships to traditional procurements', *Public Works Management & Policy*, vol. 13, no. 2, pp. 114-25.

Morimoto, R & Hope, C 2004, 'The impact of electricity supply on economic growth in Sri Lanka', *Energy Economics*, vol. 26, no. 1, pp. 77-85.

Muñoz, JI, Sánchez de la Nieta, AA, Contreras, J & Bernal-Agustín, JL 2009, 'Optimal investment portfolio in renewable energy: The Spanish case', *Energy Policy*, vol. 37, no. 12, pp. 5273-84.

Nagarajan, K 2004, *Project management*, New Age International (P) Limited.

Ngugi, PK 2012, 'What Does Geothermal Cost?–The Kenya Experience', *Short Course on Geothermal Development and Geothermal Wells. United Nations University–Geothermal Training Programme*, *Elsavador*, vol. 12.

Office of Energy Efficiency and Renewable Energy 2017, *How a geothermal power plant works* U.S. Department of Energy, viewed 28 November 2017, <https://www.energy.gov/eere/geothermal/how-geothermal-power-plant-works-simple-text-version>.

Oracle Help Center 2017, *Monte Carlo Simulation and Crystal Ball*, Oracle, viewed 02 December 2017, <https://docs.oracle.com/cd/E57185_01/CYBUG/ch02s01s02.html>.

Oxford Economics 2016, *Capital project and infrastructure spending outlook: Agile strategies for changing markets*, PwC.

Parkinson, SC & Djilali, N 2015, 'Long-term energy planning with uncertain environmental performance metrics', *Applied Energy*, vol. 147, pp. 402-12.

Paul, K 2014, 'Chapter 3 - Need for a Distinct Focus on Tail Risk: In No Uncertain Terms', in K Paul (ed.), *Managing Extreme Financial Risk*, Academic Press, San Diego, pp. 17-25, DOI http://dx.doi.org/10.1016/B978-0-12-417221-0.00003-4, <http://www.sciencedirect.com/science/article/pii/B9780124172210000034>.

Petty, NW & Dye, S 2017, 'Triangular distributions', <https://learnandteachstatistics.files.wordpress.com/2013/07/notes-on-triangle-distributions.pdf>.

Pisu, M 2010, 'Tackling the infrastructure challenge in Indonesia', *OECD Economic Department Working Papers*, no. 809.

Polackova, H 1999, 'Contingent government liabilities: a hidden fiscal risk', *Finance and development*, vol. 36, pp. 46-9.

Pratama, AB 2016, *Pemerintah hapus utang PDAM Senilai Rp4,2 Triliun (The government writes off water companies' debt valued Rp 4.2 trillion)*, CNN Indonesia, viewed 16 Aug 2016, <http://www.cnnindonesia.com/nasional/20160503150612-20-128391/pemerintah-hapus-utang-pdam-senilai-rp42-triliun/>.

Presiden Republik Indonesia 2005, *Peraturan Pemerintah Nomor 24 Tahun 2005 tentang Standar Akuntansi Pemerintah: Pernyataan Nomor 09 (Government Accounting Standard number 09 regarding Accounting for Liabilities)*, Republik Indonesia, Jakarta.

President of the Republic of Indonesia 2014a, *Geothermal Law number 21*, Jakarta.

—— 2014b, *Government Regulation Number 79 Year 2014 concerning National Energy Policy*, Republic of Indonesia, Jakarta.

—— 2015, *Presidential regulation number 38 year 2015 concerning cooperation between government and business entities in infrastructure provision*, Jakarta.

Pritchard, CL 2014, *Risk Management: Concepts and Guidance, Fifth Edition*, Taylor & Francis.

PT Perusahaan Listrik Negara (Persero) 2003, *Annual Report 2002*, Jakarta.

—— 2005, *Annual Report 2004*, Jakarta.

—— 2007, *Annual Report 2006*, Jakarta.

—— 2009, *Annual Report 2008*, Jakarta.

—— 2011, *Dedicated to Serve and Liven-up the Whole Country: 2010 Annual Report*, PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2012, *Innovative Work Creating Excellence: 2011 Annual Report*, PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2013, *Brighter is Better: 2012 Annual Report*, PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2014a, *Good Corporate Governance's Excellence and Innovative Operation: 2013 Annual Report*, PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2014b, *Towards new performance level: 2014 annual report*, PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2015, *Towards new performance level: 2014 Annual Report*, Jakarta.

—— 2016a, *35,000 MW for Indonesia*, viewed 31 March 2016, <http://www.pln.co.id/35000mw/en/>.

—— 2016b, *A 35.000 MW Power Plant Program for Indonesia: 2015 Annual Report*, PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2016c, *Indonesia Electricity Company*, PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2016d, *Rencana usaha penyediaan tenaga listrik (RUPTL) PT PLN tahun 2016-2025 (Electricity Supply Business Plan of PLN 2016-2025)* PT Perusahaan Listrik Negara (Persero), Jakarta.

—— 2017, *Electricity for Developing & Prospering: 2016 Annual Report*, PT Perusahaan Listrik Negara (Persero), Jakarta.

PT Supreme Energy 2015, *Klarifikasi PT Supreme Energy (PT Supreme Energy clarification)*, viewed 15 March 2016, <http://www.supreme-energy.com/category/news-release/>.

PT. PLN (Persero) 2015, *Rencana usaha penyediaan listrik (RUPTL) PT PLN (Persero) (PT PLN (Persero) power supply business plan 2015-2024)*, PT Perusahaan Listrik Negara (Persero), Jakarta.

Purnomo, BJ & Pichler, T 2014, 'Geothermal systems on the island of Java, Indonesia', *Journal of Volcanology and Geothermal Research*, vol. 285, pp. 47-59.

Purwanto, WW, Pratama, YW, Nugroho, YS, Warjito, Hertono, GF, Hartono, D, Deendarlianto & Tezuka, T 2015, 'Multi-objective optimization model for sustainable Indonesian electricity system: Analysis of economic, environment, and adequacy of energy sources', *Renewable Energy*, vol. 81, no. 0, pp. 308-18.

PwC 2016, *Power in Indonesia: investment and taxation guide*, 4th edn, vol. November 2016, PwC.

Ramadyanto, W 2012, 'Pemekaran daerah dan risiko fiskal (new distric creation and fiscal risk)', in FR Saragih (ed.), *MP3EI: breakthrough strategy Indonesia menuju negara maju (MP3EI: Indonesia breakthrough stategy toward a developed country)*, LIPI Press, Jakarta, pp. 273-6.

—— 2013, 'PDAM: perusahaan daerah air minum? (Water company: drinkable water company?)', *Info Risiko Fiskal*, vol. 3, pp. 4-7.

Republic of Indonesia 2014, *Geothermal Act number 21* Jakarta.

Republik Indonesia 2016, *Nota Keuangan Beserta Anggaran Pendapatan dan Belanja Negara 2017 (The Indonesian National Budget for 2017)*, Republik Indonesia, Jakarta.

—— 2017, *Nota Keuangan Beserta Anggaran Pendapatan dan Belanja Negara 2018 (The Indonesian National Budget for 2018)*, Republik Indonesia, Jakarta.

Rezaie, K, Amalnik, MS, Gereie, A, Ostadi, B & Shakhseniaee, M 2007, 'Using extended Monte Carlo simulation method for the improvement of risk management: Consideration of relationships between uncertainties', *Applied Mathematics and Computation*, vol. 190, no. 2, pp. 1492-501.

Rossi, C 2014, *A risk professional's survival guide: Applied best practices in risk management*, Wiley.

Ryan, J 2012, 'Financial PPP and the age of deleveraging: a pragmatic approach to loan guarantees for U.S. infrastructure projects', *Journal of Structured Finance*, vol. 18, no. 1, pp. 86-99.

Ryan, V 2005, *What is geothermal energy?*, World Association of Technology Teacher viewed 20 October 2014, <http://www.technologystudent.com/energy1/geo1.htm>.

Rycroft, RS 2017, *The American middle class: an economic encyclopedia of progress and poverty*, ABC-CLIO.

S-kei 2012, *Schematic condensing geothermal power plant*, Wikimedia Commons, Diagram, <https://commons.wikimedia.org/wiki/File:Schematic-Condensing-Geothermal-PowerPlant-Eng.PNG>.

Sacher, H & Schiemann, R 2010, 'When do deep drilling geothermal projects make good economic sense?', *Renewable Energy Focus*, vol. 11, no. 5, pp. 30-1.

Sadorsky, P 2012, 'Modeling renewable energy company risk', *Energy Policy*, vol. 40, pp. 39-48.

Safitri, H 2015, 'Commoditization of energy: a case of PPP scheme implementation in Central Java Power Plant/CJPP Project', paper presented to Land grabbing, conflict and agrarian-environmental transformations: perspectives from East and Southeast Asia, Chiang Mai, 5-6 June 2015.

Sanyal, SK & Yasukawa, K 2013, 'A statistical investigation on risk and economy of geothermal well drillings', *Journal of the Geothermal Research Society of Japan*, vol. 35, no. 2, pp. 83-91.

Sarmento, JM 2010, 'Do public-private partnerships create value for money for the public sector? The Portuguese experience', *OECD Journal on Budgeting*, vol. 10, no. 1, pp. 1-27.

Saufan, M 2014, *Faktor yang mempengaruhi optimalisasi PDAM kota Balikpapan saat ini (Contributing factors to optimise Balikpapan water company)* PDAM Balikpapan, viewed 17 Aug 2016, <http://pdamtirtamanggar.com/index.php/191-m-saufan-direktur-utama-pdam-balikpapan>.

Schmidt, TS, Blum, NU & Sryantoro Wakeling, R 2013, 'Attracting private investments into rural electrification — A case study on renewable energy based village grids in Indonesia', *Energy for Sustainable Development*, vol. 17, no. 6, pp. 581-95.

Sfakianakis, E & Laar, Mvd 2013, 'Fiscal effects and public risk in public-private partnerships', *Built Environment Project and Asset Management*, vol. 3, no. 2, pp. 181-98.

Shahbaz, M & Lean, HH 2012, 'Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia', *Energy Policy*, vol. 40, pp. 473-9.

Shaoul, J 2005, 'A critical financial analysis of the private finance initiative: selecting a financing method or allocating economic wealth?', *Critical Perspectives on Accounting*, vol. 16, no. 4, pp. 441-71.

Sidlo, K 2017, *Islamic Finance and Development Financial Institutions (DFIs)*, Institute of Development Studies, Brighton, UK.

Siemiatycki, M 2009, 'Delivering transportation infrastructure through public-private partnerships: planning concerns', *Journal of the American Planning Association*, vol. 76, no. 1, pp. 43-58.

Snider, CA & Youle, T 2010, 'Does the LIBOR reflect banks' borrowing costs?'.

Sorge, M 2004, 'The nature of credit risk in project finance', *BIS quarterly review*, vol. 6, pp. 91-101.

Standards Australia/Standards New Zealand 2009, *AS/NZS ISO 31000:2009 Risk management— principles and guidelines*, Standards Australia and Standards New Zealand, Sydney and Wellington.

Statistics Indonesia 2014a, *Percentage of households by province and source of drinking water, 2000-2013*, Statistics Indonesia, viewed 16 Aug 2016, <http://bps.go.id/linkTabelStatis/view/id/1361>.

—— 2014b, *Percentage of households by province and source of lighting, 2000-2013*, Statistics Indonesia, viewed 16 Aug 2016, <http://bps.go.id/linkTabelStatis/view/id/1362>.

—— 2015a, *Percentage of households by province and source of drinking Water 2014*, Statistics Indonesia, viewed 16 Aug 2016, <http://bps.go.id/linkTableDinamis/view/id/845>.

—— 2015b, *Percentage of households by province and source of lighting, 2014*, Statistics Indonesia, viewed 16 Aug 2016, <http://bps.go.id/linkTableDinamis/view/id/846>.

—— 2016a, *Length of road by level of government responsibility Indonesia, 1987-2014 (Km)*, Statistics Indonesia, viewed 1 Aug 2016, <http://bps.go.id/linkTableDinamis/view/id/808>.

—— 2016b, *Quantity of cleaned water distributed of water supply establishment by province (thousand m3), 1995-2014*, Statistics Indonesia, viewed 1 Aug 2016, <http://bps.go.id/linkTableDinamis/view/id/1113>.

—— 2016c, *Total number of water supply establishment customers, 1995-2014*, Statistics Indonesia, viewed 2 Aug 2016, <http://bps.go.id/linkTableDinamis/view/id/1111>.

—— 2017, *Monthly Indonesia consumers price indices and inflations*, Statistics Indonesia, viewed 11 April 2017, <https://www.bps.go.id/linkTabelStatis/view/id/907>.

Stefánsson, V 2002, 'Investment cost for geothermal power plants', *Geothermics*, vol. 31, no. 2, pp. 263-72.

Sujatmiko 2017, *Upayakan pemenuhan energi yang lebih berkeadilan, Kementerian ESDM luncurkan aturan melistriki 2.500*, Ministry of Energy and Mineral Resources Indonesia, <http://ebtke.esdm.go.id/post/2017/01/16/1524/upayakan.pemenuhan.energi.yang.lebih.berkeadilan.kementerian.esdm.luncurkan.aturan.melistriki.2.500>.

Sun, Y & Zhang, L 2015, 'Balancing public and private stakeholder interests in BOT concessions: minimum revenue guarantee and royalty scheme applied to a water treatment project in China', *Journal of Construction Engineering and Management*, vol. 141, no. 2, p. 04014070.

Takashima, R, Yagi, K & Takamori, H 2010, 'Government guarantees and risk sharing in public–private partnerships', *Review of Financial Economics*, vol. 19, no. 2, pp. 78-83.

Tanaka, DF, Ishida, H, Tsutsumi, M & Okamoto, N 2005, 'Private finance for road projects in developing countries: Improving transparency through VFM risk assessment', *Journal of the Eastern Asia Society for transportation studies*, vol. 6, pp. 3899-914.

Tang, L, Shen, Q & Cheng, EW 2010, 'A review of studies on public–private partnership projects in the construction industry', *International Journal of Project Management*, vol. 28, no. 7, pp. 683-94.

Ter-Minassian, T 2005, 'Government guarantees and fiscal risk', *Washington, DC, International Monetary Fund—Fiscal Affairs Department*.

The Federal Reserve Bank of St. Louis 2017, *6-Month London Interbank Offered Rate (LIBOR), based on U.S. Dollar© (USD6MTD156N)*, The Federal Reserve Bank of St. Louis, viewed 2 April 2017, <https://fred.stlouisfed.org/series/USD6MTD156N#0>.

The Japan Bank for International Cooperation 2013, *Project financing and political risk guarantee for Sarulla geothermal power plant project in Indonesia*, The Japan Bank for International Cooperation., viewed 21 April 2017, <http://www.jbic.go.jp/en/information/press/press-2013/0331-19625>.

—— 2017a, *Annual report 2016*, The Japan Bank for International Cooperation, Tokyo.

—— 2017b, *Project financing for Muara Laboh geothermal power project in Indonesia*, The Japan Bank for International Cooperation, viewed 21 April 2017.

The President of the Republic of Indonesia 2006, *Presidential regulation number 71 on assignment PT Perusahaan Listrik Negara (Persero) in accelerating development of coal power plant projects*, Jakarta.

—— 2007, *Presidential regulation number 91 on amendments of presidential regulation number 86 year 2006 concerning government guarantee on acceleration development of coal power plant*, Jakarta.

—— 2009a, *Presidential regulation number 29 on guarantee and interest subsidy by central government in accelerating water provision*, Jakarta.

—— 2009b, *Presidential regulation number 59 on amendments on presidential regulation number 71 year 2006 concerning assignment PT Perusahaan Listrik Negara (Persero) in accelerating development of coal power plant projects*, Jakarta.

—— 2010a, *Presidential regulation number 4 on assignment to PT Perusahaan Listrik Negara (Persero) in accelerating development of renewable energy, coal and gas power plants*, Jakarta.

—— 2010b, *Presidential regulation number 78 on infrastructure guarantee in public-private partnership provided through infrastructure guarantee fund*, Jakarta.

The Republic of Indonesia 2014, *Financial Notes and State Revenue and Expenditure Budget Year 2015*, Jakarta.

Timilsina, GR & Shrestha, RM 2006, 'General equilibrium effects of a supply side GHG mitigation option under the Clean Development Mechanism', *Journal of Environmental Management*, vol. 80, no. 4, pp. 327-41.

U.S. Energy Information Administration 2016, *Geothermal Explained*, U.S. Department of Energy, viewed 28 November 2017, <https://www.eia.gov/energyexplained/index.cfm?page=geothermal_home>.

Victorian Department of Treasury and Finance 2015, *Victorian government risk management*

framework, the State of Victoria Melbourne.

Vose, D 1996, *Quantitative risk analysis: a guide to Monte Carlo simulation modelling*, John Wiley & Sons.

Wells, LT 2007, 'Private power in Indonesia', *Bulletin of Indonesian Economic Studies*, vol. 43, no. 3, pp. 341-64.

Wibowo, A & Kochendoerfer, B 2011, 'Selecting BOT/PPP infrastructure projects for government guarantee portfolio under conditions of budget and risk in the indonesian context', *Journal of Construction Engineering and Management*, vol. 137, no. 7, pp. 512-22.

Wibowo, A, Permana, A, Kochendörfer, B, Kiong, RTL, Jacob, D & Neunzehn, D 2012, 'Modeling contingent liabilities arising from government guarantees in Indonesian BOT/PPP toll roads', *Journal of Construction Engineering & Management*, vol. 138, no. 12, pp. 1403-10.

Wibowo, A & Wilhelm Alfen, H 2014, 'Identifying macro-environmental critical success factors and key areas for improvement to promote public-private partnerships in infrastructure', *Engineering, Construction and Architectural Management*, vol. 21, no. 4, pp. 383-402.

World Bank 2014, *Manufactures unit value index*, The World Bank, viewed 20 November 2016, <http://data.worldbank.org/data-catalog/MUV-index>.

—— 2017, *World development indicator*, 1960-2016.

World Bank, ADB & IDB 2014, *Public-Private Partnerships Reference Guide Version 2.0*, World Bank, Washington.

Wüstenhagen, R & Menichetti, E 2012, 'Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research', *Energy Policy*, vol. 40, pp. 1-10.

Yescombe, ER 2002, *Principles of Project Finance*, Elsevier Science.

Yoe, C 2012, 'Principles of risk analysis', *Decision making under uncertainty. Taylor & Francis group, LLC, Boca Raton*.

Yusuf, AA, Komarulzaman, A, Hermawan, W, Hartono, D & Sjahrir, K 2010, *Scenarios for climate change mitigation from the energy sector in Indonesia: the role of fiscal instruments*, Department of Economics, Padjadjaran University.

Zavodov, K 2012, 'Renewable energy investment and the clean development mechanism', *Energy Policy*, vol. 40, pp. 81-9.